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THURSDAY, FEBRUARY 13, 1873

MODERN APPLICATIONS OF THE DOCTRINE OF NATURAL SELECTION*

NOTWITHSTANDING the objections which are still made to the theory of Natural Selection on the ground that it is either a pure hypothesis not founded on any demonstrable facts, or a mere truism which can lead to no useful results, we find it year by year sinking deeper into the minds of thinking men, and applied, more and more frequently, to elucidate problems of the highest importance. In the works now before us we have this application made by two eminent writers, one a politician, the other a naturalist, as a means of working out so much of the complex problem of human progress as more especially interests them.

Mr. Bagehot takes for granted that early progress of man which resulted in his separation into strongly marked races, in his acquisition of language, and of the rudiments of those moral and intellectual faculties which all men possess; and his object is to work out the steps by which he advanced to the condition in which the dawn of history finds him,—aggregated into distinct societies known as tribes or nations, subject to various forms of government, influenced by various beliefs and prejudices, and the slave of habits and customs which often seem to us not only absurd and useless, but even positively injurious. Now every one of these beliefs or customs, or these aggregations of men into groups having some common characteristics, must have been useful at the time they originated; and a great feature of Mr. Bagehot's little book is his showing how even the most unpromising of these, as we now regard them, might have been a positive step in advance when they first appeared. His main idea is, that what was wanted in those early times was some means of combining men in societies, whether by the action of some common belief or common danger, or by the power of some ruler or tyrant. The mere fact of obedience to a ruler was at first much more important than what was done by means of the obedience. So, any superstition or any custom, even if it originated in the grossest delusion, and produced positively bad results, might yet, by forming a bond of union more perfect than any other then existing, give the primitive tribe subject to it such a relative advantage over the disconnected families around them, as to lead to their increase and permanent survival in the struggle for existence. In those early days war was perhaps the most powerful means of forcing men to combined action, and might therefore have been necessary for the ultimate development of civilisation. Freedom of opinion was then a positive evil, for it would lead to independent action, the very thing it was most essential to get rid of. In early times isolation was an advantage, in order that these incipient societies might not be broken up by intermixture, and it was only after a large number of such little groups, each with its own idiosyncrasies, habits, and beliefs, had been formed, that it became advantageous for them to meet to intermingle or to struggle together, and the stronger to drive out or exterminate the weaker. Out of the great number of petty tribes thus formed, only a few had the qualities which led to a further advancement. The rest were either exterminated or driven out into remote and inaccessible or inhospitable districts, and some of those are the "savages" which still exist on the earth, serving as a measure of the vast progress of the human race. Yet even these never show us the condition of the primitive man; they are men who advanced up to a certain point and then became stationary:—

"Their progress was arrested at various points; but nowhere, not even in the hill tribes of India, not even in the Andaman Islands, not even in the savages of Terra del Fuego, do we find men who have not got some way. They have made their little progress in a hundred different ways; they have framed with infinite assiduity a hundred curious habits; they have, so to say, *screwed* themselves into the uncomfortable corners of a complex life, which is odd and dreary, but yet is possible. And the corners are never the same in any two parts of the world. Our record begins with a thousand unchanging edifices, but it shows traces of previous building. In historic times there has been but little progress, in prehistoric times there must have been much."

Again our author shows how valuable must have been the institution of caste in a certain stage of progress. It established the division of labour, led to great perfection in many arts, and rendered government easy. Caste nations would at first have a great advantage over non-caste nations, would conquer them and increase at their expense. But a caste nation at last becomes stationary; for a habit of action and a type of mind which it can with difficulty get rid of is established in each caste. When this is the case, non-caste nations soon catch them up, and rapidly leave them far behind.

This outline will give some idea of the way in which Mr. Bagehot discusses an immense variety of topics connected with the progress of societies and nations and the development of their distinctive peculiarities. The book is somewhat discursive and sketchy, and it contains many statements and ideas of doubtful accuracy, but it shows an abundance of ingenious and original thought. Many will demur to the view that mere accident and imitation have been the origin of marked national peculiarities; such as those which distinguish the German, Irish, French, English, and Yankees: "The accident of some predominant person possessing certain peculiarities set the fashion, and it has been imitated to this day"; and again, "Great models for good or evil sometimes appear among men who follow them either to improvement or degradation." This is said to be one of the chief agents in "nation-making," but a much better one seems to be the affinity of like for like, which brings and keeps together those of like morals or religion or social habits; but both are probably far inferior to the long-continued action of external nature on the organism, not merely as it acts in the country now inhabited by the particular nation, but by its action during remote ages and throughout all the migrations and intermixtures that our ancestors have ever undergone. We also find many broad statements as to the low state of morality and of intellect in all prehistoric men, which facts hardly warrant, but this is too wide a question to be entered

* "Physics and Politics; or, Thoughts on the Application of the Principles of 'Natural Selection' and 'Inheritance' to Political Society." By Walter Bagehot. (King and Co., 1872.)

"Histoire des Sciences et des Savants depuis deux Siècles suivie d'autres Études sur les Sujets Scientifiques en particulier sur la Sélection dans l'Espèce Humaine." Par Alphonse de Candolle. (Genève: H. Georg, 1873.)

upon here. In the concluding chapter, "The Age of Discussion," there are some excellent remarks on the restlessness and desire for immediate action which civilised men inherit from their savage ancestors, and how much it has hindered true progress; and the following passage, with which we will conclude the notice of Mr. Bagehot's book, might do much good if by means of any skilful surgical operation it could be firmly fixed in the minds of our legislators and of the public:—

"If it had not been for quiet people, who sat still and studied the sections of the cone, if other people had not sat still and worked out the doctrine of chances, the most 'dreamy moonshine,' as the purely practical mind would consider, of all human pursuits; if 'idle star-gazers' had not watched long and carefully the motions of the heavenly bodies, our modern astronomy would have been impossible; and without astronomy, 'our ships, our colonies, our seamen,' all that makes modern life, could not have existed. Ages of quiet, sedentary, thinking people were required before that noisy existence began, and without those pale preliminary students, it never could have been brought into being. And nine-tenths of modern science is, in this respect, the same; it is the produce of men whom their contemporaries thought dreamers—who were laughed at for caring for what did not concern them—who, as the proverb went, 'walked into a well from looking at the stars'—who were believed to be useless, if anyone could be such. And the conclusion is plain, that if there had been more such people, if the world had not laughed at those there were, if rather it had encouraged them, there would have been a great accumulation of proved science ages before there was. It was the irritable activity, the 'wish to be doing something,' that prevented it. Most men inherited a nature too eager and too restless to find out things; and even worse—with their idle clamour they 'disturbed the brooding hen,' they would not let those be quiet who wished to be so, and out of whose calm thought much good might have come forth. If we consider how much good science has done, and how much it is doing for mankind, and if the over-activity of men is proved to be the cause why science came so late into the world, and is so small and scanty still, that will convince most people that our over-activity is a very great evil."

In the second work, of which we have given the title, the veteran botanist, Alphonse de Candolle, sets forth his ideas on many subjects not immediately connected with the science in which he is so great an authority. The most important, though not the longest, essay in the volume is that on "Selection in the Human Race," in which he arrives at some results which differ considerably from those of previous writers. In a section on "Selection in Human Societies or Nations," we find a somewhat novel generalisation as to the progress and decay of nations. Beginning with small independent states, we see a gradual fusion of these into larger and larger nations, sometimes voluntary, sometimes by conquest, but the fusion always goes on, and tends to become more and more complete, till we have enormous aggregations of people under one government, in which local institutions gradually disappear, and result in an almost complete political and social uniformity. Then commences decay; for the individual is so small a unit, and so powerless to influence the Government, that the mass of men resign themselves to passive obedience. There is then no longer any force to resist internal or external enemies, and by means of one or the other the "vast fabric" is dismembered, or falls in ruins. The Roman Empire, and the Spanish Possessions in America, are examples of this process in the past; the Russian Empire and our Indian Possessions will inevitably follow the same order of events in a not very distant future.

Although M. de Candolle is a firm believer in Natural Selection, he takes great pains to show how very irregular and uncertain it is in its effects. The constant struggles and wars among savages, for example, might be supposed to lead to so rigid a selection, that all would be nearly equally strong and powerful; and the fact that some savages are so weak and incapable as they are, shows, he thinks, that the action of natural selection has been checked by various incidental causes. He omits to notice, however, that the struggle between man and the lower animals was at first the severest, and probably had a considerable influence in determining race-characters. It may be something more than accidental coincidence that the most powerful of all savages—the negroes—inhabit a country where dangerous wild beasts most abound; while the weakest of all—the Australians—do not come into contact with a single wild animal of which they need be afraid.

Selection among barbarous nations will often favour cunning, lying, and baseness; vice will gain the advantage, and nothing good will be selected but physical beauty. Civilisation is defined by the preponderance of three facts—the restriction of the use of force to legitimate defence and the repression of illegitimate violence, speciality of professions and of functions, and individual liberty of opinion and action under the general restriction of not injuring others. By the application of the above tests we can determine the comparative civilisation of nations; but too much civilisation is often a great danger, for it inevitably leads to such a softening of manners, such a hatred of bloodshed, cruelty, and injustice as to expose a nation to conquest by its more warlike and less scrupulous neighbours. Progress in civilisation must necessarily be very slow, and to be permanent must pervade all classes and all the surrounding nations; and it is because past civilisations have been too partial that there have been so many relapses into comparative barbarism. All this is carefully worked out, and is well worthy of attention.

In the last section, on the probable future of the human race, we have some remarkable speculations, very different from the somewhat utopian views held by most evolutionists, but founded nevertheless on certain very practical considerations. In the next few hundred or a thousand years the chief alterations will be the extinction of all the less dominant races, and the partition of the world among the three great persistent types, the whites, blacks, and Chinese, each of which will have occupied those portions of the globe for which they are best adapted. But, taking a more extended glance into the future, of 50,000 or 100,000 years hence, and supposing that no cosmical changes occur to destroy, wholly or partially, the human race, there are certain well-ascertained facts on which to found a notion of what must by that time have occurred. In the first place, all the coal and all the metals available will then have been exhausted, and even if men succeed in finding other sources of heat, and are able to extract the metals thinly diffused through the soil, yet these products must become far dearer and less available for general use than now. Railroads and steamships, and everything that depends upon the possession of large quantities of cheap metals, will then be impossible, and sedentary agricultural populations in warm and fertile regions will be the best off. Population will have lingered longest around the greatest masses of coal and iron, but will finally become most densely aggregated within the tropics. But another and more serious change is going on, which will result in the gradual diminution and deterioration of the terrestrial surface. Assuming the undoubted fact that all our existing land is wearing away and being carried into the sea, but by a strange oversight, leaving out altogether the counteracting internal forces, which for countless ages past seem always to have raised ample tracts above the sea as fast as subaërial denudation has lowered them, it is argued that, even if all the land does not disappear and so man become finally extinct, yet the land will become less varied and will consist chiefly of a few flat and parched-up plains, and volcanic or coralline islands. Population will by this time necessarily have much diminished, but it is thought that an intelligent and persevering race may even then prosper. "They will enjoy the happiness which results from a peaceable existence, for, without metals or combustibles it will be difficult to form fleets to rule the seas or great armies to ravage the land;" and the conclusion is that, "such are the probabilities according to the actual course of things." Now, although we cannot admit this to be a probability on the grounds stated by M. de Candolle, it does seem a probability, at some more distant epoch, on other grounds. The great depths of the oceans extend over wide areas, whereas the great heights of the land are only narrow ridges and peaks; hence it has been calculated that the mean height of the land is only 1,000 feet, while the mean depth of the sea is about 15,000 feet. But the sea is 2½ times as extensive as the land, so that the bulk or mass of the land above the sea level will be only about one thirty-seventh of the mass of the ocean. Now, does not this small proportion of bulk of land to water render it highly probable that the forces of elevation and depression should sometimes cause the total or almost total submersion of the land? Of such an epoch no geological record could be left because there could be no strata formed, except from the *débris* of coral islands, and such a period of destruction of the greater part of terrestrial life may have repeatedly occurred between the period when the several Primary or Secondary formatio s were deposited. At all events, with such a proportion of land and sea surface as now exists, with such a small bulk of land above the enormous bulk of water, and wi h no known cause why the dry land rather than the sea-bottom should be constantly elevated, we must admit it to be almost certain that great fluctuations of the area of the land must occur, and that, while those fluctuations could not very considerably increase the area of the land they might immensely diminish it. There is here, therefore, a cause for the possible depopulation of the earth likely to occur much sooner than any cosmical catastrophe.

The largest and most elaborate essay in the volume is that on the "History of the Sciences and of Scientific Men for the last two Centuries." In this the author endeavours to arrive at certain conclusions as to the progress of science under different conditions and in different countries, the influence of political institutions and of heredity, and various other phenomena, by a method which is novel and ingenious. He takes account only of the men honoured as foreign associates or members by the three great European Scientific bodies, the Royal Society of London and the Paris and Berlin Academies. By this means he avoids all personal bias, and secures, on the whole, impartiality. The tables drawn out by this method are examined in every possible way, and the results worked out in the greatest detail. The main conclusion arrived at is the determination of a series of eighteen causes favourable to the progress of science; and it is shown that a large proportion of these are present in a considerable degree in countries where science flourishes, while they are almost wholly absent in barbarous or semi-civilised countries where science does not exist.

Another interesting essay is that on the importance for science of a dominant language, and it contains some very curious facts as to the way in which the English language is spreading on the Continent. M. de Candolle believes that in less than two centuries English will be the dominant language, and will be almost exclusively used in scientific works.

There are also short but very interesting essays on methods of teaching drawing and developing the observing powers of children, on statistics and free will, and on a few other subjects of less importance, all of which are treated in a thoughtful manner, and illustrate one of the views on which much stress is laid in this work, viz., that the mental faculties which render a man great in any science are not special, but would enable him to attain equal eminence in many other branches of science or in any profession al or political career.

ALFRED R. WALLACE

HÄCKEL ON SPONGES

Die Kalkschwämme. Eine Monographie. Von Ernst Häckel. 2 vols., with an additional vol. of 60 lithographic plates. (Berlin, 1872.)

THIS splendid contribution to the knowledge of the sub-class of Calcareous Sponges is worthy of the high reputation of Prof. Häckel. In the preface he speaks of it as one of the many results of the stimulus given to zoology by the Darwinian Theory; and the list of those who have contributed the materials on which this monograph is based is honourable alike to the author and to the friendly helpers from our own and every other civilised country. It includes the names of Agassiz from the United States, Allman from Edinburgh, Percival Wright from Dublin, Barboza du Bocage from Lisbon, Lacaze Duthiers from Paris, the lamented Clapaède from Geneva, Eschricht and Sars from Christiania, Steenstrup from Copenhagen, and Lieberkuhn, Peters, Oscar Schmidt, Semper, von Siebold and many others from Germany. In addi ion to this, the author has himself collected sponges in Heligoland, Nice, Naples, Messina, the Canaries and Mogador, Algesiras, Bergen, and the neighbouring Norwegian coast, and lastly in the Adriatic Sea.

With this admirable material, and, what is no less important, with the philosophical spirit which a mere specialist always lacks, it is no wonder that a work of the first importance has been produced.

The first chapter gives an appreciative account of the admirable labours of Prof. Grant, and of the subsequent contributions to the subject by Johnston, Bowerbank, Lieberkühn, Carter, Oscar Schmidt, and Kölliker. The defects of Mr. Bowerbank's "Monograph of British Sponges" are clearly pointed out, but its great merits receive equally cordial recognition, while the criticism passed on Dr. Gray's "Classification" is as just as it is severe.

After a description of the methods of examination, the author proceeds to give a detailed account of the anatomy and natural history of the calcareous sponges, and this occupies the greater part of the first volume. The second is devoted to a detailed description of the whole group in systematic order, with diagnosis of species and ample synonomy. The plates in the third volume, drawn by Prof. Häckel with the camera lucida, are admirably exact, though artistic effect is sometimes sacrificed to a somewhat diagrammatic clearness. They remind one of the excellent illustrations of Bronn's "Thierreich."

The class of sponges is divided into *Fibrospongiæ*, including most of Grant's and Bowerbank's siliceous and ceratose genera, *Myxospongiæ*, represented by *Halisarca* and *Calcispongiæ vel Granticæ*. This third class contains three families, Ascones (Leucosolenia Bowerbank), Leucones (Leuconia Bowerbank), and Sycones (Grantia Bowerbank), represented by *Ascetta*, *Leucetta* and *Sycetta* respectively. The genera are chiefly characterised by their spicula.

The author agrees with Oscar Schmidt in deducing all known sponges from a single primitive form (Archispongia, Protospongia), which he supposed to have resembled *Halisarca* more than any other existing genus. He regards the class as very distinct from the Protozoa, and most nearly related to the Cœlenterata, a view with which English readers are familiar from Mr. E. R. Lankester's interesting paper on Zoological Affinities of Sponges in the Annals and Magazine of Natural History (vol. vi. 1870). Indeed it was the position taken by Leuchart himself in 1854, seven years after the sub-kingdom of Cœlenterata had been established by himself and Frey. If we admit that each sponge-pyramid is not a colony of Protozoa, but a multicellular organism, its likeness to a polyp is very striking: the chief differences are the absence of tentacles and of thread-cells. The latter structures, however, have, we believe, been detected in some Mediterranean sponges since the publication of Prof. Häckel's work.

Comparing the "Stammbaum" given at the end of the first volume with that in the third edition of the "Schöpfungsgeschichte" (1872), published five months earlier, we find that the author now makes all sponges descend through "Archispongia," and "Protascus" from an equally hypothetical "Gastræa," while the Cœlenterata diverge from Protascus as Archydra. This makes the affinity less close between Myxospongiæ on the one hand, and between Calcispongiæ and Coralligena on the other. The modification brings the Stammbaum nearer to the classifications actually used by other zoologists and is so far an advantage.

With regard to nomenclature, Prof. Häckel defends the proposal which he made in 1869 to revive the old name of Zoophyta (used by our countryman Wotton in 1552) in order to include sponges (or Porifera) and Cœlenterata (or, as he prefers to call them, Acalephæ). Admitting the justice of the classification, there seems no sufficient justification for the change of names. 1. Priority belongs to the name given by those who first establish true affinities, and not to vague and fanciful names given two hundred years before Linnæus. 2. To say "Zoophyta" is no worse a name to revive than "Vermes" is sufficiently to condemn it. 3. Whether the cavity in a sea-anemone is all stomach or partly perivisceral may admit of dispute, but "Cœlenterata" only affirms that the animal is hollow; and if the term suggests either interpretation, it rather lends itself to Prof. Häckel's. 4. If another word must be invented to apply to Anthozoa (or "Coralla") and Hydrozoa (or "Hydromedusæ") in common, Huxley's "Nematophora," suggested in 1851, is just as good as "Acalephæ," which was used in a more restricted sense by Cuvier. But it is not impossible that before long neither term will be properly exclusive of sponges.

These perpetual changes of names and invention of fresh ones to fit kinsfolk of every shade of propinquity and even avowedly mythological ancestors, is a real drawback to the value of such excellent works as this, and is almost as bad as the endless nomenclature of the species-mongers with whom Prof. Häckel is so justly indignant. However the new wine is still working, and we may say of even "endless genealogies"—

"Doch sind wir auch mit diesen nicht gefährdet,
In wenig Jahren wird es anders sein:
Wenn sich der Most auch ganz absurd geberdet,
Es gibt zuletzt doch noch 'nen Wein."

And this book will remain an important contribution to philosophical zoology, no less than to the special history of the group to which it is devoted. P. S.

OUR BOOK SHELF

Grotesque Animals. Invented, Drawn, and Described by E. W. Cooke, R.A., F.R.S., F.G.S., F.Z.S., &c. (London: Longmans, Green, and Co., 1872.)

MR. E. W COOKE possesses so high a reputation, not only as one of the leading artists of the day, but also as a man eminently devoted to science, as evidenced by the fact of his having attained the double distinction of Royal Academician and Fellow of the Royal Society, that anything proceeding from his pencil cannot fail to be worthy of notice, and we have accordingly looked through this quaint collection of facsimile drawings with very great interest. Mr. Cooke states, in his preface, that he commenced this series of "grotesque combinations," to which he also assigns the euphonious title of "Entwickelungsgeschicte" (history of development), while seeking rest and relief on the Somersetshire Coast after the dissipation attendant upon the meeting of the British Association at Manchester, in 1864, and that the idea of publication was forced upon him by friends who wished to have copies of the drawings. We are not surprised at his numerous friends and admirers desiring that these results of his holiday recreations should be given to the world; for, apart from the merits of the drawings in an artistic point of view, containing, as they do, powerful delineations of animal forms, they exhibit a singular and amusing fertility of imagination, the *disjecta membra* of birds, beasts, and fishes, being worked up together in a variety of fantastic forms which it would puzzle Mr. Darwin or Professor Owen to classify. The plates are accompanied by short descriptions, also by Mr. Cooke, and intended, he says, "as a key to aid the unintiated in animal lore." We give our readers the following descriptions as a sample:—" Plate v. No. 1. An odd fish—Platax—with dress of a bivalve shell, *Pecten Gibbosus*. The feet of a sprat-loon, *Colymbus Stellatus*, and tail of Beroe. No. 2. *Encrinus entrocha*, a Lily-encrinite, wears the head-dress of a porpita, one of the Acalephæ. Her dress being of Flustra, her right arm is a Pentelasmis, her left a species of Serpula. No. 3. This pig-faced lady, whose body is '*Parasmilia centralis*,' has wings of *Avicula cygnipes* (both species from the chalk), and limbs of a bird (species unknown). . Plate x. No. 1. This scaly creature, capped by Cephalaspis, has the feet of a Brazilian porcupine, the heterocercal tail of a Palæozoic fish, and the lower jaw and tusks of Dinotherium wherewith to scratch himself.. Plate xiii. No. 3. This ancient spinster, truly Palæozoic, has the triturating teeth of a fish, *Cestracion Philipi*; her cap is an Argonauta, her body that of the Port Jackson shark, her fan (Spanish, of course) a Renilla. *Isis hippuris* furnishes her arms . Plate xviii. No. 1. This hollow character, formed of the lower jaw of the hippopotamus, has very diverse arms, the right being an Ancyloceras, the left *Hamites attenuatus*. His head-gear is well got up with hide, horns, and the beak of a spoonbill! Plate xx. No. 1, thanks to Monte Bolca and its elevated strata of *dried* fish, we have *Semiophorus vellifer* (a fish of the Eocene.) With Scutes on his neck, and the claws of a lion, he walks his chalks; an upper cretaceous shell, *Plagiostoma spinosum*, defends his body." Many of the plates remind us of the gambols of the crustaceæ and other marine animals in *Babil and Bijou*, and we have no doubt that Mr. Boucicault, in his next attempt to "improve the British Drama," will find in this volume an endless variety of suggestions for humorous stage effects. We must not omit to mention the admirable manner in which the drawings have been reproduced by Mr. Sawyer of the Autotype Fine Art Company, the plates being exact facsimiles of the drawings. We anticipate an extensive circulation for this beautifully-executed and entertaining work.

G. I. F. C.

Abstract of the Reports of the Surveys and other Geographical Operations in India for 1870-71.

WE learn from these reports that during the season of 1870-71, the Great Trigonometrical Survey has been proceeded with on six series, and the complete work is represented by 11,203 square miles of principal, and 10,076 of secondary triangulation. The total area surveyed up to 1871 by the Topographical Surveys which do not include the Topographical work of the Trigonometrical Survey, is 665,909 square miles, three times the area of France. The Geological Survey has been going on more briskly than in previous years, and the Geological Surveyors are gradually building up the materials which will enable a geological map of India to be prepared. The tidal observations, from which much was expected, and for which gauges were made and sent out to India more than two years ago, were not gone on with on account of the financial difficulties of the Indian government. The government has finally adopted Mr. Hunter's plan for the spelling of Indian names; it is as near an approach to what is known as the "scientific system," as the public in the present state of education are able to endure. The "scientific system" consists in scrupulously rendering letter for letter, without any particular care to preserve the pronunciation. Uniformity in the spelling of geographical names is a great matter, no matter on what principle it may be based.

LETTERS TO THE EDITOR

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

Inherited Instinct

THE following letter seems to me so valuable, and the accuracy of the statements vouched for by so high an authority, that I have obtained permission from Dr. Huggins to send it for publication. No one who has attended to animals either in a state of nature or domestication will doubt that many special fears, tastes, &c., which must have been acquired at a remote period, are now strictly inherited. This has been clearly proved to be the case by Mr. Spalding with chickens and turkeys just born, in his admirable article recently published in *Macmillan's Magazine*. It is probable that most inherited or instinctive feelings were originally acquired by slow degrees through habit and the experience of their utility; for instance the fear of man, which as I showed many years ago, is gained very slowly by birds on oceanic islands. It is, however, almost certain that many of the most wonderful instincts have been acquired independently of habit, through the preservation of useful variations of pre-existing instincts. Other instincts may have arisen suddenly in an individual and then been transmitted to its offspring, independently both of selection and serviceable experience, though subsequently strengthened by habit. The tumbler-pigeon is a case in point, for no one would have thought of teaching a pigeon to turn head over heels in the air; and until some bird exhibited a tendency in this direction, there could have been no selection. In the following case we see a specialised feeling of antipathy transmitted through three generations of dogs, as well as to some collateral members of the same family, and which must have been acquired within a very recent period. Unfortunately it is not known how the feeling first arose in the grandfather of Dr. Huggins's dog. We may suspect that it was due to some ill-treatment; but it may have originated without any assignable cause, as with certain animals in the Zoological Gardens, which, as I am assured by Mr. Bartlett, have taken a strong hatred to him and others without any provocation. As far as it can be ascertained, the great-grandfather of Dr. Huggins's dog did not evince the feeling of antipathy, described in the following letter.

CHARLES DARWIN

"I wish to communicate to you a curious case of an inherited mental peculiarity. I possess an English mastiff, by name Kepler, a son of the celebrated Turk out of Venus. I brought the dog, when six weeks old, from the stable in which he was born. The first time I took him out he started back in alarm at the first butcher's shop he had ever seen. I soon found he had a violent antipathy to butchers and butchers' shops. When six months old, a servant took him with her on an errand. At a short distance before coming to the house, she had to pass a butcher's shop; the dog threw himself down (being led with a string), and neither coaxing nor threats would make him pass the shop. The dog was too heavy to be carried; and as a crowd collected, the servant had to return with the dog more than a mile, and then go without him. This occurred about two years ago. The antipathy still continues, but the dog will pass nearer to a shop than he formerly would. About two months ago, in a little book on dogs published by Dean, I discovered that the same strange antipathy is shown by the father, Turk. I then wrote to Mr. Nichols, the former owner of Turk, to ask him for any information he might have on the point. He replied—'I can say that the same antipathy exists in King, the sire of Turk, in Turk, in Punch (son of Turk, out of Meg) and in Paris (son of Turk, out of Juno). Paris has the greatest antipathy, as he would hardly go into a street where a butcher's shop is, and would run away after passing it. When a cart with a butcher's man came into the place where the dogs were kept, although they could not see him, they all were ready to break their chains. A master-butcher, dressed privately, called one evening on Paris's master to see the dog. He had hardly entered the house before the dog (though shut in) was so much excited that he had to be put into a shed, and the butcher was forced to leave without seeing the dog. The same dog at Hastings made a spring at a gentleman who came into the hotel. The owner caught the dog and apologised, and said he never knew him to do so before, except when a butcher came to his house. The gentleman at once said that was his business. So you see that they inherit these antipathies, and show a great deal of breed.' "WILLIAM HUGGINS"

The unreasonable

MY attention has directed itself to a letter by Dr. Ingleby in your last number, containing two curious but inconsistent misrepresentations of my words, and therein something that, if the writer were not Dr. Ingleby, might be called an instructive instance of cynophatnism or doggimangerness—the behaviour of one who will neither understand a thing himself, nor allow other folk to understand it. As, however, the writer is Dr. Ingleby, I feel sure that a less cursory contemplation of the matter will modify his views.

The following doctrines are in the *Kritik* :—

1. At the basis of the natural order is a transcendental object.

"Das *transcendentale Object*, welches den aüsseren Erscheinungen, ingleichen das, was der inneren Anschauung zum Grunde liegt, ist weder Materie, noch ein denkendes Wesen an sich selbst, sondern ein uns unbekannter Grund der Erscheinungen, die den empirischen Begriff von der ersten sowohl als zweiten art an die Hand geben." (IVth Paralogism, of Ideality ; *First Edition.*)

2. The transcendental object is *unreasonable*, or evades the processes of human thought.

(*a*) Of the sensibility :—

"Die nichtsinnliche .. Ursache dieser Vorstellungen ist uns gänzlich unbekannt, und diese können wir daher nicht als Object anschauen." (VIth section of Antithetic.)

(*b*) Of the understanding :—

"Unser Verstand Dinge an sich selbst (nicht als Erscheinungen betrachtet) *Noumena* nennt. Aber er setzt sich auch sofort selbst Grenzen, sie durch keine Kategorien zu erkennen, mithin sie nur unter dem Namen eines unbekannten Etwas zu denken." (Ground of distinction between Phenomena and Noumena.)

3. The doctrine of the contradictions is one means by which we know this.

"Mann kann aber auch umgekehrt aus dieser Antinomie . . die transcendentale Idealität der Erscheinungen . indirect.. beweisen," &c. (VIIth section of Antithetic.)

The Kantian theory had two legs to stand upon ; one the alleged necessity of mathematical axioms, the other these alleged necessary contradictions in our ideas of the natural order. How completely the first has been amputated I hope to have shortly an opportunity of showing in a course of lectures at the Royal Institution. The doctrine, that we may infer the existence of an unknowable from supposed contradictions in the knowable, "has been developed and extended by the great successors of Kant ;" and when in "a later form" these contradictions were set forth from an ultimately empirical standpoint (*not* that of Hamilton, but of Spencer, as stated in my note) the doctrine became fit for notice in a scientific lecture. Only the contradictions themselves, however, could be criticised, and not the step from them to the existence of the unknowable, or the unknowability of the existent. And Kant's name could only be mentioned as the historical starting-point of the doctrine ; whose importance for the empiricist is mainly due to the modifications it has undergone since his time.

If Dr Ingleby will kindly look at my lecture (*Macmillan's Magazine*, October 1872) again, he will see that I have attributed to Kant no more than the above-quoted doctrines ; that I never pretended to expound Kant's form of them, or their relation to the rest of his system ; and that I never said nor accused anybody of saying either that the antithetic was unreasonable, or that any natural order of thought or things was unreasonable. In regard to the other misrepresentations he speaks of, I shall be very glad indeed to be told of them, and to be set right, provided only they exist in my words, and not in the exuberant imagination of my critic.

London, Feb. 9 W. K. CLIFFORD

P.S.—There is an important error in p. 508 of the lecture in question. The surface-tension of camphor and water is *less* than that of water, not *greater*, as there stated. The general argument depends only on there being a difference.

Prof. Clifford on Curved Space

THE friend, who (as I stated in my letter in NATURE, Feb. 6) called my attention to Prof. Clifford's address in *Macmillan's Magazine* for October last, asked me certain questions respecting curved space, which I was quite unable to answer : and another friend, occupying the foremost place among English philosophers, has since communicated to me the great discomfort which Prof. Clifford's views had occasioned him, and suggested that I should comment upon them in NATURE. I am not sure that what I have to say will prove to be helpful either to my discomforted friend, or to truth : yet the doctrine of curved space is so extraordinary in itself, and so momentous in its consequences, if it be true, that it is a fair subject for sceptical scrutiny. Moreover, I do not conceive that in commenting upon it I am going *ultra crepidam* ; for the nature of space is not a subject on which the mathematician can claim a monopoly. *In limine* allow me to express my regret that Prof. Clifford should have selected such a topic for the entertainment of a popular audience. It is quite incredible that any of his hearers could have apprehended his meaning. There was assuredly no need for the lecturer to have cast a glamour on their mental eye by the invocation of those awful names, Lobatchewsky and Gauss, Riemann and Helmholtz.

The principle, in exemplification of which Prof. Clifford expounded the doctrine in question, was this : that a law can be only provisionally universal (*i.e.* as "we find that it pays us to assume it"), but that it is theoretically universal, or true of all cases whatever, "is what we do not know of any law at all" p. 504. I fancy he would not include numerical formulæ under the term "law :" else arithmetic and algebra would afford an infinity of examples of such a law. Be that as it may, he does not select an example from either of those sciences, but from Euclidian geometry. He takes the proposition established by Euclid, that in any plane triangle the three angles added together are equal to two right angles. This he asserts we do not know as a universal truth. I now quote his own words : "Now suppose that three points are taken in space, distant from one another as far as the sun is from α Centauri, and that the shortest distances between these points are drawn so as to form a triangle : and suppose the angles of this triangle to be very accurately measured and added together ; this can at present be done so accurately that the error shall certainly be less than one minute. Then I do not know that this sum [? apart from the question of error] would differ at all from two right angles ; but also I do not know that the difference would be less than 10° " If, then, after a sufficient number of observations it were found that the deviation were greater than the assigned limit of error (less than one minute), it would follow that the Euclidian law is not universal, and that for triangles of such dimensions it is not true. The conclusion would be, then, that our Tridimensional space is not a homaloid. We need not run our heads against the ghost of a fourth dimension ; for the refinements of the geometer enable him to investigate a curved tridimensional space, just as he investigates a homaloidal tridimensional space. But all the same, it is absurd to attempt the interpretation of the results without supposing that fourth dimension as the *conditio sine quâ non*.

Now we will suppose that the triangle in question has been surveyed, and that the sum of its three angles have been found to deviate from π far beyond the assigned limit of error : what have we really got thereby ? The triangle, says Prof. Clifford, is formed by drawing "lines of shortest distance" between the three points in space. Is observation through a telescope drawing such a line ? Be it so, for the sake of argument. Then, if the conclusion to be drawn is that space is curved, I ask does it or does it not follow that the sides of the triangle are themselves curved ? Observe that if those seeming (to us) straight lines are really curves of an exceedingly small curvature, the Euclidian law is not touched Of course, then, Prof. Clifford did not mean to assert that in a case in which the sides of a triangle are not absolutely straight lines, it does not necessarily follow that the sum of its angles is equal to π: for Euclid himself is quite ready to admit that. No: Prof. Clifford must have meant that those three sides, though *absolutely straight* to us, creatures who can only imagine a homaloidal tridimensional space, are curved in a sense (thanks to a fourth dimension) which vitiates the Euclidian law.

Of course he may disclaim this interpretation: or he may assert that in the case supposed the three sides are both straight and curved, or neither straight nor curved, if such be his view. But until I see his disclaimer I shall hold that he meant to suggest to his audience that straight lines (proved to be so by the standard of straightness which is alone imaginable by creatures constituted as we are) are in another sense really curved, and as such afford an observable exception to the Euclidian Law. Now I say that, constituted as we are, we could have seen straight lines only as straight, and therefore we simply *could not* see those sides otherwise than as verifying that Law; and so we could never bring to the test of observation the question raised by the great quaternion of geometers; and therefore must for ever remain in absolute ignorance whether the space, in which we "live and move and have our being," be (in another relation) something different from what we find it to be in relation to our faculties. C. M. Ingleby

Athenæum Club, Feb. 8

Earthquake in Pembrokeshire

I have received a letter from the west part of Pembrokeshire, dated February 3, from which the following is an extract:—

"Last Saturday, at 7 A.M., my bed shook twice under me; and at the same time the servant went into the dining-room, the fire-irons rattled and the room shook; an hour later, ——'s bed shook twice."

I do not know whether any notice has been taken of the occurrence elsewhere. I have paid some attention of late years to the indications of earthquakes in this neighbourhood, and am inclined to think that slight tremulous movements take place more frequently than may have been supposed or recorded. They would naturally be unnoticed in the daytime, and their detection would depend upon accidental wakefulness at night.

Hardwick Vicarage, Feb. 8 T. W. Webb

Meteorology of the Future

It is with some satisfaction that I have read in Nature of December 12, 1872, the very interesting paper of Mr. J. Norman Lockyer, entitled "Meteorology of the Future," giving adhesion and the support of his name to the discovery of Mr. C. Meldrum, of a cycle of 11 years in the recurrence of the maximum of cyclones and rainfall in the southern hemisphere; a cycle corresponding with that already recognised in the maximum of sun-spots. But I have been somewhat surprised to see that my name has not been mentioned by Mr. Lockyer in reference to Mr. Meldrum's paper, as I have also published a paper on the connection of sun-spots with rainfalls, storms, cyclones, &c., prior to the first paper of Mr. Meldrum, which appeared in Nature, October 24, 1872. Thinking that my paper has escaped your notice, and trusting that you might have some interest to see it, I take the liberty to forward it to you with this same mail. It was published in the *Boston Daily Advertiser*, November 2, 1871. Over a year has elapsed since its publication, and few are the days on which I had no opportunity of seeing the sun and scrutinising its spots with especial care, with the aid of telescope and spectroscope; and to-day I do not see the necessity of changing a word of the conclusions which I had come to in that paper. Only it appears that, in addition to the laws which I have drawn out, the position of the moon will have to be taken in consideration as a complicating element; as it seems that the conjunction and opposition have a tendency to increase the influence of the spots on our atmosphere, while the quadrature diminishes it in a certain measure. I could make some other remarks taken from my greater experience on the subject, but they are of secondary importance, and I will wait for another opportunity to publish them.

Perhaps I did not guard myself sufficiently in my paper, and have not explained with a sufficient amount of clearness, that though the effect of sun-spots on the weather is general all over the globe, yet the result cannot be expected to be absolutely the same; as local causes, very numerous, like mountain chains, forests, rivers, coasts, oceans, and climates, have an independent influence on the distribution of rains and the direction of winds, &c. But local causes are of a secondary order, and will be easily determined when once we are sure that the primary cause of atmospheric disturbances is to be found in the solar spots L. Trouvelot

Cambridge, Mass., Jan. 27

Deep Wells

Since the question of the supply of water to deep wells was touched upon in Nature (vol. vii. p. 177), in connection with the rainfall of 1872, I have been in hopes each week of seeing the subject thoroughly and scientifically discussed. It will be recollected that while we were all sneezing and spluttering, and thoughtlessly complaining of the long-continued wet, Mr. Bailey Denton deprecated the premature interference of the Archbishop of Canterbury with the rain, on the ground that the deep wells were not yet filled. This raised a great deal of discussion; people lost their tempers over the rain; and the country seemed to be divided into three bitterly hostile parties—the supporters, the opponents, and the suppliants of Providence. But still the geologists held aloof, and no one even answered the question, "What is a deep well?" but continued to talk as if wells were divided into two classes, deep and shallow, by a hard and fast line.

I therefore venture to hope that some geologist will take up the question in your columns, and give us a few facts instead of opinions. Meanwhile, I will state the case as it appears to me. With the exception of chalk and limestone formations, deep wells are, I believe, unknown in hills. In the side of a hill water comes naturally to the surface in a spring. Wells are only required—or, at all events, deep ones—at a distance from hills. They derive their water from water-bearing strata supplied in all cases either directly from hills, or indirectly from hills through the leakage of river-beds. No amount of rain falls upon cultivated, and therefore comparatively low-lying, land in Europe, sufficient to penetrate to even a shallow well through the earth immediately around it. This, at least, I presume to be the case, for 33 per cent. of their own bulk may be taken as an average amount of water for average soils to be able to retain and hold, so that if a well were 15 ft. deep to the top of the water it could not be affected by less than 5 ft. of rainfall, and when we deduct the enormous proportion of the 5 ft. that would be lost by evaporation and intercepted by vegetation, it is manifest that even 5 ft. of rain could not penetrate 15 ft. through any ordinary average soil. How, then, could any rainfall penetrate to a "deep" well of, say 100 or 200 ft. in depth?

Feb. 9 W. Hope

THE GRESHAM LECTURES ON PHYSIC

The Hilary Term Course of Lectures on Physic were delivered at the Gresham College, Basinghall Street, by Dr. Symes Thompson, on the evenings of the 17th and 18th ult., and the subject of the discourses upon this occasion was the important and interesting one of Contagious and Infectious Diseases. The professor started on his career of familiar explanation by describing two recent instances of outbreak of infectious disease in rural districts, in which the introduction and march of the fell agent of communication through the ranks of the small community could be distinctly traced. In the one case, the infection of scarlet fever was brought to the village of Flindon, in Hampshire, by a girl who came from Worthing, and served in a small general shop which was resorted to by all the villagers. Only two houses in the village that had children in them, escaped from the disease. In the other case, enteric fever was taken to Whitchurch, in Hampshire, by a young woman from Basingstoke, who returned to Basingstoke to die, after only six days' sojourn in Whitchurch. The fever, nevertheless, spread from the house in which she stayed, and within the next seven months there were seventy cases of enteric fever in a small community numbering only 1,450 people. The instance at Whitchurch acquired especial importance and interest, because it was made the ground for an investigation and report by the Local Government

Board, which now concerns itself with matters of this class. The inspector, Dr. Thorne, found that the place had been remarkably healthy until the potential cause, or infection, of the fever was conveyed to it by this chance visitant; but that it was most cunningly and elaborately prepared to receive and energise the deadly influence when once it came in the way. About one-third of the town stands upon the porous gravel of the alluvial bed of the river Test, and into this gravel, side by side, shallow wells were dug, to furnish the place with water, and pits were hollowed for the reception of all kinds of refuse filth and exuviæ incident to the conditions of life obtaining with a town community. Special care seems to have been taken to place the wells at a somewhat lower level than the pits containing the sources of pollution, whenever this was possible, as if to make sure that the liquid refuse should run into the reservoirs of the water; and in a few road-drains that had been laid down in the streets, commodious catch-pits were provided, to serve as traps and lurking-places for the offensive waste. Piggeries and small manure-yards were profusely scattered through the streets; and when once the enteric disorder had appeared, in order that it might have the fairest possible field for its operations, it became in some instances the practice to put sound people to bed with relatives actually suffering from the fever. In the case of Whitchurch, it amounts almost to a demonstration that the bowel discharges of the chance visitant from Basingstoke, containing the poison of enteric fever, must have been passed immediately into the water that was provided for the general service of the town; and that an exhaustless supply of the particular pabulum that is required for the elaboration of fresh quantities of the poison for the propagation of the malady, was kept ready on hand with the poison and the water. Enteric fever came by chance to the neighbourhood of Whitchurch; but, once there, it cannot be said that it made itself at home, and spread through the houses of the community by chance. The most elaborate provision had been made in the township to secure for it an easy resting-place, and a ready path of dissemination.

These cases of actual occurrence were happily selected by the Gresham Professor of Physic as the text of his discourse, because they aptly illustrate the value of the popularisation of information of this class, a result which it is the object of the Gresham College to insure. In the fever outbreak at Whitchurch, enlarged upon by Dr. Thompson, and from which something like every fourteenth member of the community was infected more or less gravely before the plague was stayed, nothing could be more clear than that the lodgment and seed-bed of the pestilence was prepared for it by human agency, but of course in entire ignorance of the dreadful work that was being performed. It is scarcely possible to believe that, if any single member of the constituted "nuisance authority" and "sewer authority" of Whitchurch had ever been present at the Gresham College when a lecture upon infectious and contagious disease had been delivered by the Gresham Professor of Physic in its theatre, there would have been an eight-months-long prevalence of enteric fever in the town.

The obvious, and indeed only certain, cure for evils of this character is the spread of sound information regarding matters that affect, and physically influence, health and disease, and the enlightenment of public opinion. The inhabitants of Whitchurch were the only people in this case who could possibly have been the efficient guardians of their own well-being.

Dr. Thompson designedly touched lightly upon the precise nature of the seed-germs of contagion; he satisfied himself upon this occasion by pressing home to the ordinary understanding, the great and incontrovertible fact, that diseases of this character, which sometimes decimate crowded communities, and which at all times levy a heavy tax upon human vigour and life, are caused and spread by influences which are well known to human intelligence, and largely within the sphere of human governance and control. Each form of infectious fever has its own characteristic habit and idiosyncrasy. Enteric fever and cholera tend chiefly to disseminate themselves through water, passing into the wells and fountains of daily supply, and at times travelling from house to house in the milk-cans of the easy-conscienced dairyman. Scarlet fever hybernates in a drawer, and after long months of seclusion comes forth with some old and cast-aside garment to be thrown with it round the throat or head of some new victim, and so to start thence upon a fresh career. Typhus fever crawls sluggishly almost fron hand to hand and mouth to mouth, and is immensely sociable and companionable in its spirit, languishing away when condemned to solitary confinement. Typhoid fever generates itself where filth, overcrowding, and impure habits of life prevail; and relapsing fever glides in the track of privation and misery. But the entire band of the ruthless co-fraternity agree in their subordination to known laws, and controllable conditions.

The beneficent influences and allies upon which human intelligence draws in dealing as efficiently and successfully as it now can with the work of controlling these evil ministrants, are, in the main, careful isolation of the sick; the preservation of the water from which daily supplies are derived in uncontaminated purity; the uninterrupted ventilation alike of hospitals and dwelling-houses, and fresh air; the immediate removal from the vicinity of active human life of all material contaminations that issue from the bodies of the sick, and the destruction of their morbific influence and energy by mixing them with antiseptic and disinfecting chemical agents such as carbolic acid, sulphuric acid, chlorides of lime and zinc, permanganate of potash, and charcoal; the preservation of the vital forces and resisting powers of the living frame by a well-ordered temperate rule of life, and avoidance of any undue indulgence in any kind of excess; and above all things the cultivation of an intelligent and ever enlarging familiarity with the great material conditions of nature that have been made the means of working out the marvellous arrangements and operations of civilised human life.

In considering the influence and powers of the various health-preserving chemical substances that are spoken of as antiseptics and disinfectants, it should be understood that agents of the character of carbolic acid, which are properly antiseptics, operate mainly by arresting the progress of fermentation and decomposition, while agents of the nature of Condy's fluid (permanganate of potash), chloride of lime, and especially charcoal, which are properly disinfectants, act by absorbing the noxious products of decomposition. Dr. Thompson very prettily illustrated this part of his subject by stopping the gradual evolution of bubbles of gas from a fermenting solution of sugar by adding to it a few drops of carbolic acid, and by showing that any drinking water that contains a hurtful trace of the rotten egg gas, sulphuretted hydrogen, immediately discharges the beautiful violet colour of Condy's disinfecting fluid. But his most telling illustration was the mortal remains of a defunct rat which he presented to his audience enshrined in a glass jar, and simply embalmed in charcoal. This rat was placed in the jar with the charcoal, at the termination of its natural life, some six or eight years ago; and from that time to this has been kept in the laboratory of Charing Cross Hospital for the greater part of the time with only a light paper cover over the jar. At the present time there remains of the rat's organism only the bones and a few hairs. But throughout the lengthened period of decomposition, no trace of disagreeable smell was at any time emitted. All gaseous products of decay were at once seized, and held by the charcoal.

THE BIRTH OF CHEMISTRY
VII.

Avicenna.—Albertus Magnus.—S. Thomas Aquinas.—Roger Bacon.—Raymond Lulli.—Arnoldus de Villâ Novâ.—George Ripley.—Basil Valentine.

THE Schools and Colleges of Arabia soon gave evidence of their value by the development of several considerable geniuses, whose works formed the text-books of Europe during a portion of the Middle Ages. Prominent amongst these learned Arabians was Ali-ben-Sina, or Avicenna, who was born in 980 in the neighbourhood of Shiraz. His abilities were considerable, and no pains were spared in his education; as a boy he read the Almagestum of Ptolemy, the Geometry of Euclid, and the Philosophy of Aristotle, and later in life he studied medicine with great success. We are told indeed that at the age of sixteen he was an eminent physician, and that at eighteen he cured a caliph of some grave disorder, and was hence promoted to great honour.

Avicenna is best known by his celebrated "Canons," which were translated at an early date into Latin, and often printed under the title of "Canones Medicinæ." This work has been translated into the languages of all civilised countries, and for no less than six centuries was the standard medical treatise of the world.

Avicenna also wrote on Alchemy and on Chemistry. If the works attributed to him are genuine he appears to have adopted the Aristotelian theory of the four mutually convertible elements. He speaks of air as the aliment of fire, and of the metals as compounds of a humid substance and an earthy substance. This last idea evidently arose from the observation of the calcination of metals. It was well known that if certain metals, such as lead and tin, are heated for a length of time in the air they are converted into a powdery substance or calx, and it was long before it was proved that this calx is not the metal from which one of its constituents has been expelled by fire; but, on the other hand, the metal combined with another substance. Avicenna divides all minerals into four classes; viz., (1) Infusible minerals; (2) Minerals which are fusible and malleable, that is, metals; (3) Sulphurous minerals; and (4) Salts. He noticed that mercury can, by heat, be caused to unite with sulphur and produce a solid body, having different properties from its constituents.

Avicenna was largely indebted for his knowledge to Alfarabi and to Rhazes. The latter wrote on medicine, and was one of the first to introduce substances formed artificially by chemical means into medicine.

Turning now our attention to European alchemists we meet at the outset with the name of Albertus Magnus (b. 1193, d. 1282), who became Bishop of Ratisbon in 1259. Various works on Alchemy are attributed to him: he wrote on the philosopher's stone, on the origin of metals, and on minerals; and he has described at some length various chemical operations, such as sublimation and distillation, and various forms of apparatus, such as aludels, alembics, and water-baths. He followed Geber in the belief that metals are composed of sulphur and mercury, and that different metals are produced by different combinations, and to some extent by the variations in the purity, of these substances. Albertus Magnus employs the term *affinity* (*affinitas*) to designate the cause of the combination of sulphur with silver and other metals; in this precise sense, applied to all cases of chemical combination, the term is used in the present day. He also speaks of sulphate of iron as *vitriol*, a name which it long retained. He describes the preparation of nitric acid, its principal effects upon certain metals, and its utility for separating silver from gold, inasmuch as it will dissolve the former and not the latter. Cinnabar, or sulphide of mercury, had long been known and used as a source of mercury; Albertus proved that it consists of sulphur and mercury by preparing it artificially, by subliming sulphur with mercury.

Albertus was not alone learned in Alchemy; he was a profound theologian, a scholar, an astronomer, a physician, and some said an adept in magic and necromancy. He embodied his wisdom in twenty-one folios, which were published in a collected form in 1651. M. Lenglet Dufresnoy, in his "Histoire de la Philosophie Hermetique," has mentioned several magical operations gravely attributed to Albertus Magnus by various writers. The most noticeable piece of magic was the sudden transformation of a winter's day into glowing summer:—"Horridam hyemem," says Trithemius, "in florigeram fructiferamque vertit." It is said that once during a very severe winter, he invited Count William of Holland, when he was passing through Cologne, to a feast. The Count, on his arrival with a considerable retinue, was surprised to find the feast spread in the garden, in which there were several feet of snow; and this treatment so angered him that he remounted his horse and prepared at once to leave his inhospitable host.

Then the monk falling on his knees besought
The Count to sit one moment at the board.
He having done so, a most wondrous change
Passed on the instant over all around.
The dark clouds floated off and left a sky
Intensely blue, an air exceeding clear;
The sun shone brightly, and the warm south wind
Laved their pale cheeks and warmed them into life.
They sit on greenest grass, the snow is gone,
Sweet flowers bloom beneath their very feet,
Ripe peaches blush upon the garden wall,
And orange blossoms scent the humid air.
A swarm of insect life on droning wing
Is floating up above them in the breeze.
The voice of birds is heard; the cooing dove
Speaks softly to her mate; the nightingale
Trills a sweet lay, half hidden in the leaves.
All nature is most joyous in her garb
Of brightest summer day, and all things seem
To glory in the flood of warmth and light.

Upon this, the Count expressed considerable astonishment, as although he had heard a good deal of the magical powers of his host, he was quite unprepared to find him capable of changing the seasons. As soon as the feast was ended, Albertus Magnus repeated a magical formula—

Now snow obscures the air; the flowers fade.
The trees are torn by pitiless strong winds
And weep their shrivelled fruit upon the earth;
All sound of life is gone, a roar of elements
Succeeds the plaintive quavering of the leaves.
The birds fall dead to earth, and the dark air
Betokens fearful tempests yet to come.

So the Count and his retinue rush off into the house to warm themselves, and thus ends the feast of Albertus Magnus. Some will have it that the story alludes to a winter garden, unknown at that time, which had been devised by Albertus for the preservation of rare plants. Middle Age books on science abound with such stories, and the belief in them was almost universal, as it well might be in an age in which the power of witches and wizards was acknowledged, and the raising of the dead was an admitted possibility. Brücker (*Institutiones Historiæ Philosophicæ*) says:—"Quæ enim de ejus convivio magico narrantur, merito inter inficeti seculi fabulas referuntur, quæ ex ignorantia rerum naturalium, eo tempore crassissima et Alberti mirabili rerum physicarum cognitione prodierunt."

In the church of S. Andreas in Cologne they show to this day the shrine and relics of Albertus—the accomplished churchman, scholar, magician and alchemist, of whom Trithemius says, "Magnus in Magia Naturali, major in Philosophia, maximus in Theologia."

Albertus had for his pupil the "angelic doctor," S. Thomas Aquinas (b. 1225, d. 1274), who was a great alchemist, and who wrote a treatise called "The most secret Treasure of Alchemy," together with some other works on the subject, which are equally obscure and unintelligible. He wrote also on the artificial preparation of gems, by fusing glass with certain substances, like oxide of copper, to communicate different colours; he mentions that if copper be heated with white arsenic, the former becomes white, something like silver. According to some, S. Thomas Aquinas was the first to employ the term *amalgam*, to designate a compound of any metal with mercury. S. Thomas was, like his master, a magician. We are told that between them they constructed a brazen statue, which Albertus animated with his *elixir vitæ*. It was useful as a domestic servant, but very talkative and noisy; nor could they cure it of this propensity. It happened one day that S. Thomas, who was a mathematician, was deeply engaged in a problem, but was continually interrupted by the talking statue; at length in a rage he seized a hammer and smashed it to atoms, to the great regret of his master.

Our great countryman Roger Bacon (b. 1214) also suffered from a charge of magic, and during his residence in Oxford was severely persecuted in consequence. He replied to the charges made against him by the admirable treatise "De nullitate magiæ," and in it clearly showed that what his contemporaries mistook for the work of spirits, were in good sooth the ordinary operations of Nature. In this work he speaks of gunpowder, although somewhat obscurely. "Mix," says he, "together saltpetre, *luru vopo vir* *con utriet*, and sulphur, and you can make thunder and lightning, if you know the method of mixing them." Elsewhere he says, "a small quantity of matter properly manufactured, and not larger than one's thumb, may be made to produce a horrible noise and sudden flash of light." The third constituent of gun-

FIG. 11.—An alchemist hermetically sealing a flask containing a solution of gold.

powder is designated under the anagram *luru vopo vir con utriet*, for it was dangerous in those days to speak too plainly; indeed Bacon tells us that he adopted an obscure style both on account of the example of other writers, and of propriety, and also on account of the dangers of plain speaking. According to some writers, the following passage is to be found in Bacon's writings:—"Sed tamen salis petræ, *luru mone cap ubre*, et sulphuris, et sic facies tonitrum si scias artificium." Thus the saltpetre and the sulphur are directly designated, while the anagram *luru mone cap ubre* is convertible into *carbonum pulvere*, the remaining constituent—powdered charcoal. It is improbable that Roger Bacon invented gunpowder, although he was the first to know of its properties in England; he probably procured the knowledge from an Arabic source. Gunpowder was first used by the English at the battle of Crecy in 1346, 61 years after the death of Bacon; at this time it was apparently unknown to other European nations.

Roger Bacon is believed to have been far in advance of his times in all matters of science. To him has been attributed the invention of the telescope and *Camera obscura*, and several discoveries of a later date. The evidence is less conclusive than one could wish, but enough remains in his writings to prove that he was a very learned man and profound thinker. His "Opus Majus" clearly proves that he fully recognised the value of the experimental method, and of the inductive philosophy afterwards so ably advocated by his namesake Francis Bacon. Roger Bacon wrote largely on alchemy. Many of the alchemical MSS. in the British Museum are transcripts of portions of his works, among the more celebrated of which we may mention the "Medulla Alchymiæ," "Secretum Secretorum," and "Speculum Secretorum." He collected together the principal alchemical facts of his predecessors, and appears in many matters to have closely followed Geber. Bacon describes the distillation of organic substances, and alludes to the inflammability of the evolved gases. He proved that air is the food of fire by burning a lamp in a closed vessel.

Raymond Lulli (b. 1235) is by some asserted to have been a pupil of Roger Bacon. He was a voluminous writer on alchemy, his most celebrated treatise being his "Ultimum Testamentum." He also wrote on transmutation, on the Philosopher's Stone, and on magic. Lulli does not appear to have added to the chemical knowledge of his predecessors; he followed Geber closely, and was well acquainted with the processes and compounds which he describes. He describes alcohol under the names of *aqua vitæ ardens*, and *argentum vivum vegetabile*, and was in the habit of

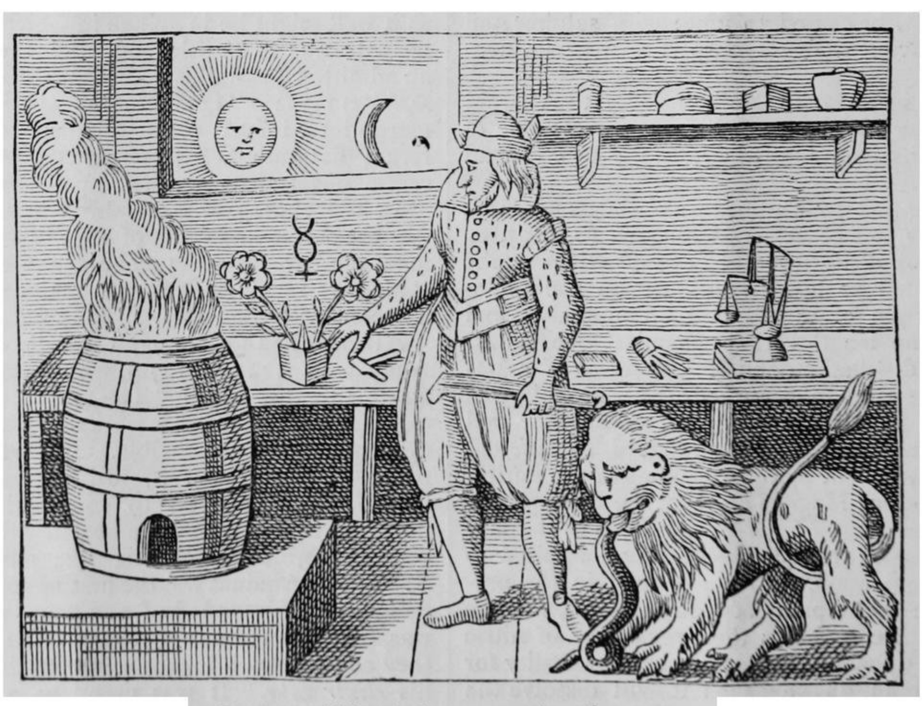


FIG. 12.—Alchemical representation of processes.

rendering it anhydrous by allowing it to stand in contact with dry carbonate of potassium. He was also acquainted with ammonia.

Whatever Lulli's knowledge may have been, he obtained great reputation as a successful alchemist. He asserts in his "Ultimum Testamentum" that he converted fifty thousand pounds weight of base metals into gold. He is said to have been employed by one of the Edwards to make gold, and to have furnished His Majesty with six millions of money. Dickenson tells us that Lulli had a laboratory in Westminster Abbey, in which, after his departure, a quantity of gold dust was found.

Of the general tone and character of alchemical writings we shall speak more fully in the next article. Of the professors of the art little more need be said; a long list of names might be given, but it would be found that they did little to develop what afterwards became the science of chemistry. Let us glance at the work of a few of the remaining alchemists. Arnoldus de Villâ Novâ (b. 1240) was a great alchemist and physician, and the author of many works on the subject. His "Rosarius Philosophorum" purported to contain a key to all alchemical operations. He followed Geber closely. He considered a solution of gold the most perfect medicine, and we usually find that such solution was recommended by alchemists as a necessary constituent of the elixir vitæ, and essential for the work of transmutation. In Fig. 11 the solution of gold in the flask is represented by the sun emitting rays. The simple disc of the sun is the more common symbol for gold.

Arnoldus also distilled various oils and essences. He contended that sulphur, arsenic, mercury, and sal ammoniac—all volatile bodies be it noted—are the souls of metals, and are given off during calcination. He also affirmed that silver is intermediate between mercury and other metals, just as the soul is intermediate between the spirit and the body. Arnoldus is said to have had for his pupil Pope John XXII., an accomplished alchemist, who left at his death eighteen millions of florins, which the alchemists fondly cite as a proof of the possibility of transmutation. Our own George Ripley, Canon of Bridlington in Yorkshire (b. about 1460) wrote a poem on alchemy, and passed for a successful disciple of the art, but we cannot point to a new fact which he elucidated. He divided all chemical operations into twelve processes—Calcination, dissolution, separation, conjunction, putrefaction, congelation, cibation, sublimation, fermentation, exaltation, multiplication, and projection. Several MS. copies of his poem exist in the British Museum, bound up with copies of the works of Roger Bacon and earlier writers. Here is a specimen of his rugged rhymes:—

> The fyrst chapter shall be of naturall *Calcination* ;
> The second of *Dyssolution*, secret and phylosophycall ;
> The third of our elementall *Separation* ;
> The fourth of *Conjunction* matrimoniall ;
> The fyfth of *Putrefaction* then followe shall :
> Of *Congelation Albyficative* shall be the sixt,
> Then of *Cybation*, the seaventh shall follow next.

One of the most celebrated of the alchemists was Basil Valentine, who was born at Erfurt in 1394. According to Olaus Borrichius his works were accidentally discovered in the wall of a church at Erfurt many years after his death. A thunderbolt struck the church and exposed to view the long-lost alchemistical treasures. Basil Valentine was the author of many treatises, the most important being his "Currus Triumphalis Antimonii," in which he discusses the properties of antimony and of many of its compounds. He regarded the metals as compounds of salt, sulphur, and mercury; and he was acquainted with many metallic compounds, among others nitrate of mercury, sulphide of arsenic, red oxide of mercury, chloride of iron, sulphate of iron, fulminating gold, carbonate of lead, acetate of lead, and the oxides of lead. He was aware that iron precipitates copper from solution, and that solution of potash precipitates iron from solution. He was well acquainted with the preparation of nitric and sulphuric acids, and used them for various purposes of dissolution. In order to obtain nitric acid he distilled powdered earthenware with nitre, or equal parts of nitre and green vitriol, or nitre with finely powdered flints. He obtained fuming sulphuric acid by distilling green vitriol, after the manner still practiced at Nordhousen and elsewhere. Basil Valentine wrote very obscurely and was fond of symbolical designs. Woodcuts 12 and 13 are taken from his works, and represent various processes imperfectly described. Thus the lion in Fig. 12 would represent a solution of a metal, the serpent another solution, or perhaps the serpent a metal, and the lion devouring it a solvent; the sun and moon are watching the operation, and the symbol of mercury appears between two roses. Fig. 13 represents some operation which is thus thus described by the principal figure:—I am an old, infirm, debilitated man, my soul and spirit (represented by the two boy-headed birds above his head) leave me, and I assimulate the black crow. In my body are found salt, sulphur, and mercury. This may possibly refer to the solution of gold in aqua regia: it loses its metallic nature, its solidity and lustre, and assimulates the acid; but one may conjecture in vain concerning the enigmatical devices in which some of the alchemists took so much delight, and which they often employed, like Roger Bacon's anagram, to conceal the full significance of their operations or discoveries.

FIG. 13.—Alchemical representation of processes.

The following extract, in which he treats of the generation of metals, will show the style of Basil Valentine's writing:—

"Therefore think most diligently about this; often bear in mind, observe, and comprehend that all minerals and metals together in the same time, and after the same fashion, and of one and the same principal matter are produced and generated. That matter is no other than a mere vapour, which is extracted from the elementary earth by the superior stars or by a sidereal distillation of the macrocosm, which sidereal hot infusion, with an airy sulphureous property, descending upon inferiors, so acts and operates, as in those metals and minerals is implanted spiritually and invisibly a certain power and virtue, which fume afterwards resolves in the earth into a certain water, from which mineral water all metals are thenceforth generated and ripened to their perfection, and thence proceeds this or that metal or mineral according as one of the three principles acquires dominion, and they have much or little of sulphur and salt, or an unequal mixture of them; whence some metals are fixed, that is constant or stable; some volatile and easily mutable, as is seen in gold, silver, copper, iron, lead, and tin."

Now this is by no mean the most obscure piece of alchemical writings with which we shall come in contact.

G. F. RODWELL

GLACIER MOTION

IN making some experiments on the freezing of water some time ago it was noticed that after the same water had been melted and frozen a number of times it generally burst the tube in which it was frozen. On looking for an explanation of this phenomenon, it became at once evident that the experiment contained the germ of the explanation of glacier motion. Every time the water was frozen in the tube there was a mimic representation of glacier motion. The ice possessed, the first two or three times it was frozen, a certain amount of viscosity which enabled it to adapt itself to the shape of the tube, as was evident from the distortion of the upper surface of the ice in the tube. How came the ice to lose this plasticity or viscosity, this power of adapting itself to the shape of the tube, the loss of which caused it to burst the tube after it had been frozen and melted a number of times? Wherein did the ice which had only been frozen once differ from the other? The answer to this seemed to be, that the ice which had only been frozen once had more air in it than that which had been frozen and melted a number of times, as each succeeding freezing deprived the ice of a quantity of air or some other gases. The natural conclusion, therefore, seemed to be, that ice with air in it is a viscous substance, though pure ice is not. The first question then to be asked is, Is ice with air in it a viscous substance? In order to get an answer to this question, glass tubes 4-inch in diameter and twelve inches long were filled with water in which was dissolved a great quantity of air. The tubes were then placed in a freezing mixture. After the water was frozen in the tubes the tubes were slightly heated and the rods of ice withdrawn from them and placed on two supports eight and a half inches apart, and a weight of one pound hung from the centre of these ice beams. The beams at once began bending and continued bending so long as the weights were left on them, thus proving the viscosity of the ice experimented on. The ice of these beams though similar was not the same as glacier ice; other ice beams were therefore made, in as close imitation of glacier ice as possible, which was done by placing a small quantity of water in the tubes, then some snow, and pressing it firmly to the bottom of the tubes, then adding more snow, and again firmly pressing it down, and so on till the tubes were filled, as much pressure being applied as possible to the snow to drive out the water. The tubes were then placed for some time in the freezing mixture. The ice beams were afterwards withdrawn from the tubes and placed on the supports, and a weight of one pound hung from the centre. The beams of snow ice so made were found to be more easily bent than those made from the water. The rate at which they bent varied, possibly owing to there being more or less water-ice mixed with the snow-ice: one of the beams bent one inch in five minutes. Temperature seemed to have some influence on the rate of bending of these beams, but this point was difficult to determine on account of the different beams bending at different rates at the same temperature; but so far as could be ascertained from the experiments, the beams bent slower the lower the temperature. The lowest temperature used in these experiments was rather more than three Fahrenheit degrees below freezing.

Smaller rods of snow-ice were then made ·2-inch in diameter, and as it was found that these could be easily bent in the hand, it was thought possible to bend them into rings. In attempting to bend these rods round a cylinder three inches in diameter, a difficulty was met with. After the pressure had been applied a short time, and before the circle was half turned, the rods always broke with a pressure which they easily bore at the beginning. Here, then, was a difficulty. The explanation seemed to fail at the last moment. The bending had so altered the structure of the ice, that it had lost much of its viscosity and become brittle. How then are we to account for glacier ice keeping its viscosity after years of bending. On examining the fracture of the beams it appeared as if a fibrous structure had been developed in the ice by the bending. The fracture did not go straight across, but part of it ran parallel with the axis of the beam, strongly resembling the fracture of poor bar iron, crystalline at one part, fibrous at another. The bending of the ice had evidently developed a laminated structure in it, similar to that found in glaciers. This laminated structure was developed along the beams, as was to be expected; for the direction in which this structure will be developed depends more on the direction in which the particles of ice are caused to slip over each other, than on the direction in which the pressure or tension is applied. The bending having produced this laminated structure in the ice, it is evident that the beams will be weaker after this structure is developed than before, on account of the cohesion of the ice being weakened along the planes of lamination. It was thought therefore that if the pressure was taken off the ice so as to relieve the particles from strain and stop them sliding over each other, that the laminæ which had been developed in the ice, would, so to speak, become welded together, and the strength and plasticity of the beam be restored. Acting on this supposition an attempt was again made to bend the ice-beam into a circle. After a small part of the circle had been turned, the pressure was taken off the beam and a short time given for the particles to rearrange themselves; the pressure was then again applied, a small part more bent and so on. When done in this way it was found that the ice-beams were easily bent into a circle, the ends were then united by means of pressure, and a solid ring was thus produced from a straight beam of ice. These conditions of alternate rest and pressure are in all probability those which exist in glaciers. After pressure has acted at one part of the glacier, bending takes place, so relieving the ice at that part from the pressure, which comes to bear on another part of the glacier; and before the pressure again comes to bear on the first part its strength and plasticity or viscosity has been restored by rest.

Although ice under certain conditions has by these experiments been shown to be a viscous substance, to have the power of changing its shape and so enabling it to flow—though slowly—in its channel; although it has thus been shown that the viscosity of ice is a cause of glacier motion, yet it must not, therefore, be concluded that it is the only cause. Among other causes which may assist in producing glacier motion may be mentioned: 1st. The sliding of the ice over its channel; this sliding being assisted by the tendency which the ice has to melt where it rests on its channel. 2nd. The melting of the ice in front of obstacles, the melting being produced by the melting point of the ice in contact with the obstacle being lowered by the pressure of the ice behind. 3rd. The melting of the ice in the body of the glacier, by heavy pressure being brought to bear at certain points, part of the water so formed finding its way to the channel under the ice, and part being re-frozen. 4th. The crevasses in the glacier formed by the fracture of the ice. This breaking up of the ice will enable large masses of ice to move into different positions relatively to each other, much more easily than if the ice was solid. This breaking up of the ice will also make the motion due to its viscosity take place quicker than if the ice was in one mass. 5th. The old dilatation theory explains something of the motion of glaciers, though it may not explain how that motion takes place, yet it accounts for some of the pressure which produces that motion.

John Aitken

SUB-WEALDEN EXPLORATION

SINCE the last quarterly report, troublesome accidents have delayed this undertaking. On the very day of the meeting in Jermyn Street in December last, the drilling tool broke off close to the edge, leaving a flat chisel (9 in. wide tapering up to 2 in.) at the bottom of the bore. A fortnight was lost in the endeavour to extract it. Mr. Bosworth's ingenuity and patience were sorely tried; but he at last succeeded in bringing it to the top from a depth of about 96 ft. 34 ft. consisting of narrow bands of calcareous shale, alternating with argillaceous limestone in layers of from 4 to 6 in. were passed through; but on January 28, at 131 ft. from the surface, a bed of pure solid white gypsum 4 ft. in thickness, was reached and perforated, the new trifid drilling tool bringing up solid cores. This is the first time a bed of gypsum of this character has been found in Sussex, and it probably indicates the presence of the Purbeck beds. If so, strata hitherto unknown to exist in Sussex are now added to our geological information, and the scientific world will have its interest re-awakened to this, the first boring attempted in England for purely scientific purposes. Boring is a tedious and expensive process, and we hear that the preliminary cost of machinery has exhausted the treasury. Subscriptions are earnestly requested to complete the second sum of 1000*l*. promised on condition that 2000*l*. be raised. Mr. Henry Willett, Arnold House, Brighton, will be pleased to receive any sums for the purpose. It would be a great disaster indeed if the boring had to be stopped for want of funds; but we feel sure that when the state of matters is made known to the friends of science Mr. Willett will soon have to report a full treasury.

NOTES

THE candidates for the chair of Geology held by the late Prof. Sedgwick now stand as follows:—Mr. Morris, Lecturer on Geology at University College, London, and a Vice-President of the Geological Society; Mr. P. Martin Duncan, F.R.S., also a Vice-President of the Geological Society, Professor of Geology in King's College, London, and Lecturer at the Indian College of Civil Engineering at Cooper's Hill; the Rev. Osmond Fisher, formerly Fellow and Tutor of Jesus College, Cambridge; the Rev. T. G. Bonney, Fellow and Tutor of St. John's College, Cambridge; Mr. Boyd Dawkins, F.R.S., formerly on the Geological Survey, and now Director of the Museum and Lecturer in Geology at Owens College, Manchester; Mr. A. H. Green, of the Geological Survey, formerly Fellow of Gonvillle and Caius College, and now Lecturer in Geology at the School of Military Engineering at Chatham; and Mr. Hughes, of Trinity College, also on the Geological Survey. Mr. Morris has acted for the last two years as deputy to the late professor.

A CORRESPONDENT in Paris informs us that M. Janssen was to be nominated to a vacant place in the French Institute last Monday, and that there is every likelihood of his obtaining a majority of votes when the election takes place a few weeks hence. M. Janssen is to be sent to Pekin in December 1874, for the purpose of observing the transit of Venus.

PROBABLY the first telegram transmitted by the Atlantic cable, under the generous arrangement mentioned in NATURE of January 30 last, was received by the Astronomer Royal on February 7, and forwarded to us the same day. It announced the discovery of a new planet, No. 129, of the 10th magnitude, on the night of February 6: R.A. 9^h 16^m north decl. 15° 38′. Such an excellent arrangement is likely to save all disputes as to priority of discovery.

PROF. FLOWERS's Hunterian Lectures at the College of Surgeons for this year will treat of the Osteology and Dentition of Extinct Mammalia, with their geological and geographical distribution and relation to existing forms. The course commences on Monday next (the 17th) at four o'clock, and the lectures will be continued at the same hour on Mondays, Wednesdays, and Fridays until March 28. It may not be generally known that this course is open to all who wish to attend, without fee or formality.

DR. T. R. LEWIS has made the important discovery of a haematozoon, which he has provisionally named *Filaria sanguinis hominis*. In a paper lately published at Calcutta, he describes its discovery last July in the blood of a patient suffering from a disease well known in tropical countries, Chyluria. The worms appear to be present in very large numbers in the blood and in some of the secretions; indeed, they were first observed in the urine two years ago. They are evidently hematoids, but sexual distinctions have not been hitherto observed, nor is anything known of their ova or development, nor how they gain an entrance to the body. Each is inclosed in a hyaline sheath, in which it can contract and expand itself, so that they may be probably regarded as in an encysted form. The average length is ·175 of an inch, the breadth about that of a red blood-disc; they are therefore much smaller than the Guinea-worm or *Trichina spiralis*. The disease of which it is probable that they are the cause is not rare in tropical countries, and is sometimes fatal. This curious "Filaria" was discovered independently in chylous urine, by Dr. Lewis and by Wucherer, in 1870. Dr. Crevaux, of the French navy, published a memoir on the same subject a few months ago ("De l'Hematurie chyleuse ou graisseuse des pays chauds;" A. Delahaye, Paris, 1872). In the Montpellier *Revue des Sciences Naturelles*, for September, 1872, Dr. A. Corre figures and describes some specimens as transparent, colourless, and varying in size from ·2 to ·265 of a millimetre long, by ·006 to ·007 broad at the thickest part. This exactly corresponds with the diameter of a human red blood-disc, as given by Welker. He has sometimes observed a slight constriction below the head, as has Dr. Crevaux, who also noticed the dark spot supposed by Dr. Lewis to be a mouth, "qui ressemble plutôt à un amas de granulations qu'à un orifice." MM. Crevaux and Corre have been unable to distinguish any organs, only granulations forming a central line down the body, "qui simule, au premier aspect, un canal étendu de la tête à la queue." Wucherer regards the worm as probably a larval form. It is important to remark that the cases examined by their authors were all from tropical America. The descriptions and the drawing referred to abundantly confirm Dr. Lewis's admirable observations, though they are not nearly so complete. To him belongs the undivided merit of discovering this parasite in its true *habitat*, the living blood.

THE Director of the Observatory of Harvard College purposes to publish a series of astronomical engravings, which shall represent, as nearly as possible, the most interesting objects in the heavens, as they are seen with the powerful instruments of the observatory under his charge. The series will consist of at least thirty pictures, and will embrace the principal planets, moon-craters, sun-spots, solar prominences, nebulæ, and spectra of variable stars. To obtain some assistance towards defraying the expense of printing, as well as to secure for them a more general circulation than can be expected for volumes of annals of an observatory, they will be offered to subscribers at the rate of 2*l*. 10*s*. for the set. The engravings will be delivered from time to time as they are completed, and they will be followed by some pages of notes and explanations. Messrs. Trübner and Co. are instructed to register the names of intending subscribers.

THE American Government has established an Observatory at Fort Garry, Manitoba, which is, as nearly as possible, the central spot of the American continent.

AMMONITES have been discovered by Dr. Waagen ("Memoirs of the Geological Survey of India, IX.") in a carboniferous formation near Jabi, north of Shabpoor, in the N.E. of the Punjab. The form appears to be allied to some species found in the Whitby lias. The presence of this family in palæozoic rocks is a new and important observation.

SOUTH AFRICAN sportsmen have got a bad name among many people, the increasing scarcity of the various kinds of so-called "big game" being commonly attributed to their exploits. There are those, however, who think otherwise, and believe, as is doubtless the case, that the deeds of an occasional Gordon Cumming, who makes a shooting excursion up the country, had little lasting effect upon its animal and particularly its mammalian life, the decrease in which is mainly caused by the spread of settlements. The University of Cambridge seems to be of the latter opinion, and on Thursday last, by grace of the Senate, authorised the payment, from the Worts' Travelling Bachelors Fund, of 200*l*. to Mr. T. E. Buckley, F.Z.S. and B.A. of Trinity College, who is about to make an expedition into the interior from Natal, for the purpose of forming natural history collections, and especially of obtaining skeletons of the larger animals, with the understanding that specimens be sent to the Museum of the University, accompanied by reports. Mr. Buckley has had much experience as a traveller, having visited some of the wildest parts of Lapland, explored Turkey, and braved the dangers of the Gold Coast: and he has contributed, in conjunction with his fellow-voyagers Captain Elwes and Captain Shelley, to the *Ibis*, good accounts of the ornithology of the two countries last mentioned.

A SEVERE shock of earthquake was felt at Lahore on January 1, at 7.55 A.M. and at Suchin on December 31. The earthquake, which on December 15 was felt at Lehree in Eastern Cachi and Zehri and the Scinde frontier of India, was also felt at Dadur, Suhwan, Shikarpore, and Jacobabad, within British territory.

IN the beginning of January a sharp shock of earthquake was felt in the island of Imbros, opposite the Dardanelles. Several small works were destroyed, and other damage done. This was, perhaps the same as the earthquake felt on January 13 at Gallipoli, and Chanak, Kalehsi (Dardanelles), at about 10.30 A.M. The oscillation was from S. to N. This earthquake was slightly felt at Constantinople, but not at Smyrna.

THE Royal Commission on Scientific Instruction met on Tuesday and Wednesday of the present week.

WE learn, from the *British Medical Journal*, that Dr. Struthers, Professor of Anatomy at Aberdeen, gives free evening lectures on this subject to students of Divinity and Arts, and to all who take an interest in Natural science.

WE have received an "Extract from the Science Directory, revised to November 1872," showing the nature and amount of assistance afforded by and through the Science and Art Department to Instruction in Science. This gives all the information needed both by pupils or teachers who are desirous of qualifying themselves to participate in the various grants, scholarships, exhibitions, prizes, &c., by which Government seeks to encourage scientific education. Since the publication of the last directory, several alterations have been made in the administration of this department. One is that grants are given to encourage the construction of special laboratories in Schools, and collections of apparatus adapted to teaching will be sent on loan to schools under certain conditions. For the year 1873 arrangements will probably be made to enable a certain number of teachers to stay about six weeks in London, to undergo a course of instruction in teaching certain special subjects. Several improvements have also been made in the course of instruction for students who have completed their course at the ordinary Elementary School. These alterations all tend in the direction of greater stringency and thoroughness, and an attempt has been made so to frame the course, as to lay the foundation of a systematic scientific training.

WE with pleasure notice that a new local scientific society has been started at Kensington, under the title of the Kensington Entomological Society. There are now a considerable number of similar societies in the London suburbs, and we hope this one will meet with encouraging success, and produce some work of lasting value. We hope next week to give a paper read to the Society by Mr. A. Murray, 67, Bedford Gardens, Kensington, who, we have no doubt, will be glad to furnish information to anyone desirous of joining the Society.

WE are glad to see one more provincial paper devote some of its space to Science. A copy of the *Leighton Buzzard Observer* sent us devotes a whole column to scientific jottings, selected with considerable judiciousness.

MR. G. ST. CLAIR, in reference to his letter of last week, sends us a letter from the *Manchester Guardian*, of February 5, which says that the writer and two friends were walking down Oxford Street, Manchester, about 10 P.M., when suddenly the place was illuminated with a bluish light equal to the light of mid-day, and right over their heads burst, as it were, a ball of fire; instantly it shot through space, when it burst again, and finally disappeared. After a few seconds more they distinctly heard the sound of a report like thunder. The course of the meteor appeared to them to be from east to west; the time was about seven seconds.

A MEDICAL Society has been formed at Smyrna, on the basis of the Imperial Medical Society at Constantinople.

THE Abbé Moigno, after all, has brought his *Salles du Progrès* to a termination; not, however, we are glad to learn, because his praiseworthy scheme of popular education has turned out a failure, but because he has found another means of accomplishing his "great object of intellectual regeneration by true science, good and beautiful." The founders of the Catholic Circle of Workmen—a scheme apparently meant for the elevation of the French working classes—have proposed to make use of the Abbé's services, his educational staff and *matériel*, to carry out their educational plans both in Paris and in the provinces. He has, we think wisely, accepted the offer, and, although he has been compelled to terminate his own particular scheme, he will be in a much better position for accomplishing the admirable end he has in view.

MR. W B. GAMLEN, M.A., of Exeter College, has been elected Secretary to the Curators of the Oxford University Chest.

THE following information has been sent us by the scientific editor of *Harper's Weekly*:—Prof. Powell has returned from the exploration of the Colorado River of the West, having completed the examinations of the wonderful series of cañons along the course of this river about October 1 last. He then visited a group of volcanic mountains north of the Grand Cañon, composed of about sixty basaltic cones, to which he has given the name of Uinkaret Mountains (the Indian name, signifying "Where the pines grow"). An extensive series of faults has been examined by the party this year. These run in a northerly and southerly direction across the Grand Cañon, and north into the plateaus at the head of the Sevier, and some as far as the Wasatch Mountains. They are from 50 to 200 miles in length, and the drop from 100 to 3,000 ft. The fissures of these faults have been vents for volcanic eruptions, and along their courses vast floods of lava have been poured out and cones built up. A number more of the ruins of ancient communal houses have been discovered, making in all more than a hundred so far found by the party in the valley of the Colorado. One of these was situated on the crater of a volcanic cone. The collection of picture-writings (etchings on the rocks) has been much enlarged; and the seven ancient towns, called by the Spaniards the Province of Tusayan, have been revisited for ethnological purposes. The professor has also continued his studies of the Ute Indians. He has discovered among them an extensive system of mythology and a great number of rude songs, and brought with him a large collection of articles illustrating the state of the arts among the people who inhabit the valley of the Colorado, composed of stone implements, pottery, basket-ware, clothing, implements for hunting and entrapping animals, musical instruments, ornaments of feathers, bones, teeth, and claws, and various miscellaneous articles. Prof. Thompson remains in the field for the purpose of extending the exploration north, toward the Wasatch Mountains.

AN article by Herr von der Wengen, on the artificial breeding of salmon in Silesia during the season of 1871 and 1872, published in the circular of the *Deutsche Fischerei-Verein*, contains some very interesting facts in reference to this fish. As the result of four successive years of observation, he remarks that he finds salmon generally descend to the sea in the second year, and remain there not one year, as is so generally assumed, but more nearly two, before returning to the river and home of their youth. The establishment at Hammel, which has already done so much to increase the stock of salmon in the Upper Weser, has determined, from numerous observations, that a period of four years elapses between the birth of the salmon and its first return from the ocean.

OSCAR GRIMM describes Bacteria and Vibriones from his own investigations in the *Archiv für Mikrosc. Anatomie*. He has observed their conjugation and fissiparous multiplication, and also has seen leucocytes breaking up into granular matter which ultimately assumed the form of Bacteria.

PROF. MOLLER, of Lund, Sweden, has published the Ephemerides of Faye's comet for its next return to the neighbourhood of the sun. It will be in perihelion about July 18, and will continue to approach nearer and nearer to the earth till Jan. 10, 1874. It will not, however, be in a position favourable for observation, and it is very probable that not even the most powerful telescope will be able to catch it.

M. CALLAS in *Les Mondes* endeavours to account for a dry haze (*brouillard sec*) which is seen in the atmosphere at certain seasons in particular countries. At Paris he says it is clearly visible on the horizon on the morning of lovely summer days, and is regarded as the presage of fine warm weather. It is of a light roseate hue. In proportion as the day is dry and warm, the denser and higher above the horizon is the haze. This haze is seen at all heights, having been observed by Saussure in Switzerland, by Lecay and Charles Martin in Auvergne, and by Wilkomer in Spain; in all cases, the phenomenon is seen at its best when the day is dry and warm. M. Callas attributes it to the combustion of aerolites and shooting stars. The attraction of the earth, he says, causes these bodies to deviate from their regular course and to be precipitated to the earth's surface with a rapidity which certainly exceeds 20 kilometres per second, and which is sufficient to set them on fire and render them volatile. The vapours thus produced rapidly become so rarified that they may be looked upon as the ultimate limit of divisibility of insoluble bodies and form the dry mists alluded to. Obeying the law of gravity these descend to the earth from the heights where they are formed, slowly however, on account of their extreme tenuity. As they approach the earth they come under the influence of winds which dissipate them, and of cold moisture, which absorbs them. Hence it is that they are perceived only in certain countries and in warm seasons; especially in Spain, and on the table-lands of Abyssinia and Mexico. M. Callas thinks that the haze may be regarded as a sort of cosmical matter akin to that which composes the tails of comets. The hypothesis has the merit of being at least curious, and so far as we know, original.

THE first paper in the last number of the Bulletin of the French Geographical Society is in connection with a well-executed map of the chief physical features of Eastern Brazil, appended to the number. M. Charles Grad contributes a long article on the geology of the Algerian Sahara and its system of waters. Perhaps the most interesting article is by M. Paul Gaffanel on the Great Sargasso Sea in the middle of the Atlantic, the history of which he traces from the Phœnicians downwards, describes its geography historically and with reference to what is known of it at present, which seems to be comparatively little, and concludes by pointing out that the wrack or algæ of which it is composed might be put to immensely profitable industrial uses.

WE have received the prospectus of the new Italian Geographical Magazine, whose first appearance we announced last week. Dr. Petermann has written a very hearty preface for his young friend, the editor, Guido Cora, whose plan is very comprehensive, embracing not only geography proper, but also geognosy, botany, zoology, anthropology, ethnography: hence the name of the magazine.—*Cosmos.* We wish it ample success.

THE *Revue Scientifique* for Feb. 8 contains Dr. Liebreich's Royal Institution lecture on the effect of School Life on Vision in the Young.

SIR W. ARMSTRONG ON THE COAL QUESTION *

II.

AT the present moment attention is being drawn to a new method of increasing the efficiency of the steam engine by pumping heated air into the boiler. It is impossible to conjecture what theoretical considerations could have led Mr. Warsop, the discoverer of the system, to anticipate beneficial results from the adoption of such an expedient, and yet the experiments that have been made in proof of its efficacy are so authoritative that they cannot be repudiated on the ground of their being unsupported by theory. This subject, although much debated of late, is still so ambiguous and obscure that I shall take the present opportunity of stating the difficulties of the case in the hope of eliciting satisfactory explanation. Mr. Warsop's method consists in attaching to a steam engine a forcing pump for the purpose of injecting air into the boiler. The pipe from this forcing pump is formed into a coil in the flue so that the air may absorb a portion of the waste heat. After entering the boiler the pipe is laid along the bottom, and being perforated with holes allows the air to bubble up through the water at many different points. The result appears to be that, with a given expenditure of fuel, the available power of the engine is considerably increased by the action of the air-pump, notwithstanding that the power for working it is derived from the engine itself. How, then, is this to be explained? It is clear that air forced into a receiver cannot without the aid of extraneous heat give back all the power expended upon the forcing pump. There must of necessity be loss of power by friction, and also from the impossibility in practice of realising all the expansive action of the condensed air corresponding to the compressive action of the pump prior to actual injection taking place. It would be a liberal estimate to assume that one-half of the power expended on the pump is recoverable from the air. Hence, to make up the deficiency by the application of heat, we should have to double the volume of the air, which would require it to be heated to upwards of 500° F, above its initial temperature. Now, in the case of the Warsop arrangement, considering the inconsiderable heating power of the escaping gases to which the air-pipe is exposed; considering also the slow absorbing power of air, and the smallness of the surface presented by the coiled pipe, it is hard to believe that the air could enter the boiler at such a temperature as I have named; but even if it did, where is the surplus power to be found that gives the engine a palpable increase of efficiency? The mere reaction of the compressed air, with all the aid it can possibly derive from the absorption of waste heat, would barely save a loss, and certainly could never account for an important gain. It seems obvious, therefore, that whatever beneficial action is exercised by the air must be of an indirect nature, and not the immediate effect of its mechanical energy.

Four modes of action have been put forward to account for the effects obtained. Firstly, it is said that the air, in bubbling through the water, facilitates the disengagement of the steam. This may very possibly be the case, for we know that water, entirely deprived of air, may be heated in an open vessel to a temperature greatly exceeding the usual boiling point, before ebullition commences. The reason of this is, that the adhesion between the water and the containing vessel, and also between the particles of water themselves, is sufficient to restrain the formation of steam at the usual boiling heat, unless air be present to afford points of separation. So far the explanation is plausible; for if the abstraction of air from water raises the boiling point, we may infer that the addition of air will lower it. But the reduction of the boiling-point within any supposable limits, would not lessen the quantity of heat required for the production of the steam sufficiently to afford a solution; because the sum of the latent and sensible heat, though not constant, as was formerly supposed, does not vary in relation to the boiling point to such an extent as would account for any important saving in that direction. A tangible advantage might, however, accrue from the accelerated transmission of heat from the fire to the water, caused by the increase of difference which a lowered boiling point would occasion between the temperature of the water and that of the fire and gases acting on the boiler; but in the absence of thermometric experiments to show how much the boiling point is actually reduced, and how much the escaping gases are cooled, it is impossible to form any definite opinion as to the amount of this saving. It is certain, however, that unless the reductions of temperature be greater

* Continued from p. 272.

than can be readily conceded, they will not be sufficient to account for so large an economy as is said to be realised.

Secondly, it is argued that the bubbles of air virtually afford an extension of heating surface. So they do, in relation to the heat carried in by the air; but the air can only part with its heat by lessening its direct contribution to the power of the engine. Moreover, if the heat carried in by the air be insignificant in quantity, as I believe it to be, the explanation fails in every point of view.

Thirdly, it is stated that the action of the air prevents and even removes incrustation, and thereby keeps the heating surfaces free from all obstruction as regards the transmission of heat. Very careful observation would be required to establish this fact; but, granting the fact, it would follow that the advantage of injecting air would be limited by those cases in which deposit would otherwise be formed. In a boiler perfectly free from incrustation the injection of air ought to be nugatory, but this does not appear to be the case.

Fourthly, it has been ingeniously suggested by Mr. Siemens that the air passing with the steam into the cylinder may form a film on the interior surface capable of arresting, in a great measure, that condensation which is known to be so wasteful of power in unjacketed cylinders, where the steam is used expansively. It is highly probable that the air would really accumulate in this manner against the sides of the cylinder; because, while the particles of steam sank down into water, the particles of air would remain. It is also pretty clear that this film of air would intercept the abstraction of heat by the cooled material of the cylinder; but if we admit this mode of action, then it would seem to follow that it is only in the absence of a steam jacket to the cylinder that the economy of injecting air is realised, and in fact that the injection of air is merely a substitute for steam jacketing. Moreover, if such be the action of the air, pumping into the steam should, in this point of view, produce the same effect as pumping into the water.

I have dilated upon this subject more, perhaps, than necessary, but I have done so with a view to stimulate action in the matter, for it is time that the doubts and obscurities which beset the system should be cleared up, and its adoption or rejection be brought to an issue. There is no class of steam-engine in which economy of fuel is of so much importance as it is in marine engines, for not only is it an object in steam navigation to diminish the cost of coal, but it is a still greater object to save room, and thereby increase the space available for cargo. The introduction of compound engines has enabled steam to be used of much higher pressure than formerly, and with greatly increased expansive action. The result has been a saving of about 50 per cent. in the consumption of coal, and I believe I am substantially correct in saying that in steam vessels, employed on long voyages, this saving of coal has been attended with a fourfold increase of the previous carrying power. It is highly probable that still further reductions of fuel will be effected by following in the same path, which has already lead to such great economy. The pressure of steam in marine engines is still far inferior to that which is used in locomotive engines, and there is no obstacle, of an insurmountable nature, against the expansive action being increased proportionately to any further increase of pressure.

But our efforts to increase the efficiency of marine engines must not run too much in one groove. Recent improvements have been almost exclusively directed to the mode of *applying* the steam, and but little attention has been paid to the mode of *producing* it. The engine has advanced enormously in improvement, but the boiler has actually receded; for we now get less evaporative effect from marine boilers than was obtained from those previously in use. This diminution of effect has resulted from changes made in the form of the boiler, to enable it to resist the greater pressure of the steam; but there is no inherent necessity for sacrificing evaporative power to meet this requirement, as is proved by the example of the locomotive boiler, which, while it produces steam of double the pressure of that supplied by marine boilers, stands unrivalled in regard to evaporative effect. The superiority of the locomotive boiler in regard to evaporating power is chiefly due to the large capacity of its firebox, which affords ample space above the surface of the fuel for perfecting the combustion of the gases. In the old form of marine boiler the flame space above and beyond the fire was also very large, and the evaporation per pound of coal was nearly as great as in the locomotive. But this advantage has been sacrificed in the modern form of boiler, by adopting a cylindrical fire chamber within the boiler. This form is very favourable to strength, but it affords very little head-room over the fire, and the consequence is that, although the tubular heating surface is relatively as great as before, the evaporation per pound of coal has fallen considerably. I do not say that the locomotive form of boiler, pure and simple, is that which ought to be adopted for marine engines, but it is well worth consideration, whether by adopting the same principle of construction, a more efficient boiler would not be obtained for marine engines. A more powerful draught would probably be required than is now necessary, but this could be obtained by known mechanical methods, applied either to *draw* air through the furnaces, or to *force* it into a closed stoke-hole. The production of draught by auxiliary power, would have the great advantage of enabling the rate of combustion to be regulated at pleasure, so as to meet the varying demand for steam, and it would also facilitate the application to marine boilers of mechanical firing, which does not succeed with a slow draught, and requires a variable draught to meet the fluctuating production of steam required at sea. The great number of stokers required in large steamers, the severity of the work, and the inefficiency of the method they pursue, as evidenced by the dense clouds of smoke they produce, render the introduction of mechanical firing in such vessels a matter of the utmost importance; and I do not believe that any of the difficulties which appear to stand in the way are incapable of removal.

I must not dismiss the subject of steam power without some allusion to its application to agriculture. In no description of steam-engine has economy of fuel been more perseveringly and successfully followed out than in engines for agricultural use; and Mr. Bramwell, in his late address to the Mechanical Section of the British Association, does full justice to the mechanical engineers who have been the means of bringing these engines to such a high degree of efficiency. It is satisfactory to see that the application of steam to the cultivation of the land, and to every kind of farming operation, is rapidly extending; for if the food producing power of the land has to be increased, it must be by substituting, as far as possible, the comparatively cheap power of steam, for the labour, both of men and horses. The greatly increased demand for labour in manufacturing occupations, as well as for mining and constructive purposes, will certainly diminish the supply of rural labour and increase its cost. Such a result is not to be regretted, considering how miserably ill requited farm labour in most parts of England has been; but unless the growing cost of agricultural labour and of horse work can be counterpoised by a more extensive use of steam power, we may expect much of the land in this country to be thrown out of cultivation. Very different are the views of those who maintain that food would be more economically produced by increasing, instead of diminishing, the labour employed on the land. Such is the doctrine of those who advocate the parcelling out of the land in small plots to peasant holders, and who even contend that waste lands, incapable of profitable return by ordinary treatment, could, by this means, be advantageously cultivated. It would, indeed, be a retrograde step to renounce the aid of capital and mechanical skill in tillage, and fall back upon the primitive system of spade husbandry. If there be a country in the world where such a mode of cultivation is the best, that country is assuredly not England, where all the resources of science and skill are necessary to the maintenance of a large population, under adverse conditions of soil and climate, and where labour is more highly paid in manufacture than in agriculture.

I have had considerable personal experience of steam cultivation, and am a thorough believer in its efficacy; but I may here draw attention to a very general subject of complaint concerning the machinery and implements employed for the purpose. I refer to the frequency of breakages due to insufficient strength in the construction. If makers of the apparatus, used in all the varieties of steam tillage, could only be induced to be more liberal in the use of material, the introduction of their machines would be very greatly accelerated.

I must also touch upon the subject of steam traction on common roads, which has lately received a considerable impulse from the introduction of Mr. Thomson's invention of India-rubber tyres. The number of horses in this country is enormous, and being great consumers of food, their maintenance is a heavy charge on the resources of the nation. Next to human power, horse power is the most expensive that we can use, and we may welcome the dawn of a period when steam will, to a great extent, supplant animal power in our streets and highways.

But these, and all other extensions of steam power, involve greater consumption of coal, and we may well look with anxiety to our diminishing stock of this precious mineral, which, when once expended, can never be replaced. It will therefore, be a fitting conclusion to this address briefly to review the results arrived at by the late Royal Commission, of which I was a member, as to the extent of our available coal and its probable duration. I will not trouble you with the vast amount of detailed information collected by the Commissioners as to the extent of the British coal fields, nor with the elaborate calculations of the quantities of coal which those coal fields contain, but I will chiefly direct my observations to those points of the inquiry which fall within the province of mining and mechanical engineering, and to the broad conclusions at which the Commissioners arrived.

It being well known that a great extent of our coal lies at depths greatly exceeding those of our present deepest mines, it was essential to the inquiry that the limit of possible depth of working should be approximately defined. One of the committees, therefore, into which the Commission was divided, was entrusted with this branch of the subject, and having acted in the capacity of chairman to that committee, I am especially familiar with its proceedings. It fortunately happens that water is never met with in large quantities at great depths, and it is easy to exclude it from the upper portion of a deep shaft, by the modern process of encasing the shaft with cast-iron segments. Nothing, therefore, is to be feared on the score of excessive pumping power being required; neither would there be any practical difficulty in drawing coals from the utmost depth to which we should have to descend. Steel wire ropes tapering in thickness towards the downward end, would not be overstrained by their own weight added to the usual load, and even if the depth were carried to such an extreme as to render the strain on the rope due to its weight a serious difficulty, the alternative of drawing at two stages could be adopted.

With regard to explosive gas it might have been anticipated that the greater superincumbent weight upon deep coal would cause more gas to exude, and thereby render the workings more fiery, but this does not appear to be the case. On the contrary, the evidence given before the committee on this point was to the effect that the evolution of gas appeared generally to diminish with increase of depth. In short, the only cause which it is necessary to consider as limiting the practicable depth of working, is the increase of temperature which accompanies increase of depth. The rate of this increase of temperature is about 1° F. for every 60 feet in depth, starting from 50 feet from the surface, where the temperature is in this country 50° at all seasons. The questions involved in this increase of temperature are, at what depth would the air become so heated as to be incompatible with human labour, and what means could be adopted to reduce the temperature of the air in contact with the heated strata. A great deal of interesting evidence was heard by the Commission as to the limit of human endurance of high temperature. The natural temperature of the human body, or rather of the blood which circulates through it, is 98°. A higher temperature is the condition of fever, and the maximum of fever heat appears to be about 105°. Labour appears to be impossible, except for very short intervals when the external conditions are such as to increase materially the normal temperature of the blood. The temperature of the air may be considerably in excess of 98° without unduly heating the blood, provided the air be very dry, because the rapid evaporation which then takes place from the body keeps down the internal temperature; but if the air be humid, this counter-action does not take place, or not in a sufficient degree, and then the blood absorbs heat from the surrounding medium and the condition of fever sets in. Now, in a coal mine, the air is never very dry, and is often very moist, and we must, therefore, regard a temperature of 98° in a coal mine as the extreme limit that could be endured by men performing the work of miners. For my part, I believe this temperature is beyond the limit of possible continuous labour in a mine, and most persons familiar with the interior of coal mines will agree with me in thinking that even 90° would prove a very distressing temperature, and one which would render the cost of labour much greater than usual. However, granting the practicability of working in a coal mine in an atmosphere at 98°, the next question is, what depth would involve that temperature of the air? The depth at which the earth would exhibit a temperature of 98° would be about 3,000 feet, but it is a different question at what depth the air circulating through the mine would acquire that temperature. The air being cold when it enters the workings at the bottom of the shaft, absorbs heat with great avidity from the surfaces of the passages through which it flows. As it travels along it continues to absorb heat, but less rapidly as its own temperature increases. The rate of absorption is complicated by the superficial cooling of the passages by the contact of the air. This cooling action is necessarily greatest near the shaft, where the air is coldest, and diminishes by increase of distance, so that both the air, and surfaces against which it sweeps, become hotter as the length of the air-course is increased. The progress towards complete assimilation of temperature is much slower in the permanent air courses than at the working face of the coal, because the coal at the face being newly exposed is hotter, and therefore communicates heat more readily to the air. In any case, however, the air will eventually acquire the heat due to the depth, if its contact with the strata be sufficiently prolonged. It follows, therefore, that the temperature of the air in a mine depends on the extent of the workings as well as on the depth of the pit. But great depth involves extensive workings, because the cost of the sinking could only be repaid by working a large area of coal. Extremely deep mines will consequently possess *both* the conditions tending to produce a high temperature of the air, and unless those conditions can be counteracted by some artificial expedient, the air would acquire the temperature of 98°, assumed to be the limit of practicable labour at a depth not greatly exceeding 3,000 feet.

It is a common idea that increase of temperature may be kept down to any extent by increase of ventilation, but this opinion will not bear examination. In the first place it requires an extravagant increase of motive power to accelerate the velocity of the current of air in any considerable degree, because the resistance increases in a ratio somewhat exceeding the cube of the velocity. In fact, the only way of materially increasing the volume of air is by enlarging the sectional area of the shafts and air-courses, which would be attended both with difficulty and expense. Assuming, however, that it would be generally practicable to effect a large increase of ventilation under the conditions incident to extremely deep mining, it is necessary to consider what would be the cooling effect realised by so doing. This is a very complex question, because the reduction of temperature in the air increases the emission of heat from the strata, and because the rate of absorption is affected, not only by difference of temperature, but also by the velocity of the current.

The uncertainty on the question of the power of air to absorb heat when flowing at different velocities and in different volumes through heated air-courses, and the difficulty of reasoning out any conclusion upon the subject led me to make, for the guidance of the committee, a series of experiments in which air was forced, in varying quantities, through pipes of different lengths and sizes, immersed in hot water, the temperatures being observed at the point of emergence. In these experiments the pipes were regarded as representing, on a small scale, the air-courses of a deep mine; the hot water being the equivalent of the heated strata through which the air would be conveyed. The particulars of these experiments will be found in the appendix to the evidence taken by the committee, and the results are embodied in tables, illustrated by diagrams, which show the progressive heating of the air as it travels along the passages, and exhibit the reductions of temperature effected by successive increments of the volume of air. From these tables and diagrams it will be seen that, with short pipes, representing short distances from the shaft, increased circulation has considerable effect in lowering temperature; but with pipes representing long distances from the shaft, the cooling effect of increasing the volume of air becomes insignificant. The conclusion to which the committee came, as to the depth at which coal could be worked, is expressed in the following words:—"The depth at which the temperature of the earth would amount to 98° would be about 3000 ft. Under the long-wall system of working a difference of about 7° appears to exist between the temperature of the air and of the strata at the working faces; and this difference represents a further depth of 420 ft., so that the depth at which the temperature of the air would, under present conditions, become equal to the heat of the blood, would be about 3,420 ft. Beyond this point the considerations affecting increase of depth become so speculative, that the committee must leave the question in uncertainty; but they consider that it may be fairly assumed that a depth of at least 4,000 ft. could be reached."

The committee decline to deal with hypothetical expedients for overcoming the difficulties, but they recognised the possibility of future discovery and experience counteracting, in some unknown degree, the effects of heat and humidity in restricting the depth of working. It will, therefore, be for mining and mechanical engineers to bring all the resources of their science to bear upon this difficult problem of counteracting terrestrial heat, at depths where it approaches the limit of human endurance. The Commissioners adopting 4,000 ft. as the probable limit of practicable depth, came to the conclusion that there exists in this kingdom an aggregate quantity of about 146,480 millions of tons of available coal. If we assume that the future population of this country will remain constant, and that the consumption for domestic and manufacturing purposes, including exportation, will continue uniform at the present quantity, or merely vary from year to year without advancing, then our stock of coal would represent a consumption of 1,273 years. But if, on the other hand, we assume that population and consumption will go on increasing at the rate exhibited by the statistics of the last fifteen years, or, I might probably say, of the last fifty years, had accurate statistics been so long recorded, then the whole quantity of coal would, as shown by Mr. Jevons, be exhausted in the short space of 110 years. It will be generally admitted that the truth is likely to lie between these two extremes. The Commissioners refrained from expressing an opinion as to what the period of duration would actually be, but they presented certain alternative views of the question, resulting in periods varying from 276 to 360 years. But, all these estimates of duration have reference to the time required for absolute exhaustion of available coal, and leave untouched the important question of how long we are likely to go on before we become a coal-importing instead of a coal-exporting country. The computation of quantities made by the Commissioners, includes all coal seams exceeding 1 ft. in thickness, whatever the quality may be, and it is obvious that vast quantities of such coal can never be worked, except at a price which would render it more advantageous to purchase coal from abroad than to work it from such unfavourable beds. If, at the present time, while working our best and most available coal, our markets will barely exclude the coal of Belgium, what will be our position when driven to inferior coal more costly to work? If we look to cheaper labour for enabling us to work less valuable coal, I fear we shall look in vain; but there is one hope for a longer endurance of our prosperity as dependent on our coal, and that hope rests on the skill and perseverance of mining and mechanical engineers, who, even now, are called upon to lessen, by all the resources of mechanical science, the amount of human labour required in coal mines.

SCIENTIFIC SERIALS

THE *Monthly Microscopical Journal*.—The first paper is one of Mr. Parker's excellent studies, being on the osteology of the head of the sparrow-hawk. The first paragraph contains a generalisation which will surprise many ornithologists, for the Cariama is included among the raptorial birds; is this a result of the study of the skull? The accompanying drawings are excellent.—Dr. Royston-Piggott gives two articels, "On an Aërial Stage Micrometer," and "On the Spherules which compose the Ribs of the Scales of the Red Admiral Butterfly, and the Lepissna Saccharina."—An ingenious method of obtaining an equal illumination in both tubes of a binocular is contributed by Mr. W. R. Bridgman; and Mr. Stewart endeavours to prove that the hair follicles of the negro's scalp are curved instead of straight; he also describes clearly the framework of the sucking feet of the Echinus.—These papers are followed by abstracts of interest, including several from the American journal, the *Lens*.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, Feb. 6.—"Memoir on the Osteology of Hyopotamidæ." by Dr. W. Kowalevsky. The paper is intended to fill a deficiency in our knowledge of the extinct creation by giving a complete osteology of one family of the Paridigitate Ungulate. It has been supposed that fossil representatives of this family would exhibit a less reduced skeleton and a more complete number of digits than recent genera; yet such is not the case. The genera *Anoplotherium* and *Liphodon* present in their feet the same degree of reduction as in recent Ruminants, save the confluence in a canon-bone. Notwithstanding this, they have been considered the progenitors of the Ruminantia, from a deficiency in other forms. The present paper introduces a new form, known only by the teeth till now; these, the *Hyopotamidæ*, vary considerably in specific and generic form, ranging from the Lower Eocene up to the Lower Miocene period, and in size from a rabbit to a hippopotamus. The Eocene species, except one termed *diplopus*, have not lost the lateral digits, and are included in the genus *Hyopotamus*. The division of the Ungulata into *Paridigitata* and *Imparidigitata* must have occurred about the cretaceous period, as shown by the diversity exhibited by both groups from the lowest Eocene. The former, the *Paridigitata*, split very anciently, perhaps in the chalk, into those with tubercular, and others with crescentic teeth. These groups, once separate, kept entirely apart, but frequently followed parallel lines of descent. Following these two divergent lines of descent, both groups culminate at the present time in such forms as *Phacochœrus* and *Dicotyles* for one group, and the *Bovidæ* for the other, links between these being absent. The Paridigitata with crescentic teeth will be termed *Par. selenodonta*, and those with tubercular *Par. bunodonta*. To the first group belong *Anoplotherium*, *Liphodon*, *Hyopotamus*, and others, together with the existing ruminants, whilst the second embraces the *Suina*, *Hippopotamina* and *Entelodon*. There is in some cases difficulty in deciding whether the teeth are tubercular or crescentic, the lobes being so thick.

It is important to find some osteological characters to confirm the above division, and the hand and foot from their variations suggested probable data. In tracing the Paridigitata in time, there is a marked tendency to the gradual reduction of the manus and pes, and an advantage to the individual apparently arises from the simplification. By comparison of all forms, a simple structure of the manus and pes may be obtained, such as was probably possessed by the common ancestor, and such a type is nearly retained by *Hippopotamus*, and was possessed by *Hyopotamus*. In none of these forms is the limb pentadactylate. Supposing the feet to be pentadactylate, the following is the disposition of the digits in the type:—The two outer digits (the fourth and fifth) are always supported by one bone, the unciform in the manus, and the cuboid in the pes; the three succeeding inner digits are supported each by a separated bone, the third, second and first cuneiform in the pes, and the os magnum, trapezoideum, and trapezium, in the manus. In the latter the third digit touches the unciform, and the second the magnum; the second digit of the pes touches the third cuneiform. The first digit being lost in all Ungulata, the trapezium and first cuneiform support the second digit.

Beginning with this type, which was probably exhibited by the progenitors of the Paridigitata, the reduction along both lines of descent may be followed, and in doing so a series of parallel modifications may be obtained, though it is found among the crescent-toothed line that the reduction is much more rapid than along the tubercular toothed. By reduction of the foot is meant that locomotion is carried on by the two middle toes instead of by the original four; and this seems to be an advantage to the organism, as it is exhibited by all descending lines of Ungulata. Going further into detail, it is found that both in Selenodont and Bunodont Paridigitata, a two-fold method of reduction of the manus and pes, a simple or *inadaptive*, and an elaborate or *adaptive* method is observed. In the first or *inadaptive* mode of reduction, the foot, whilst losing its lateral digits, acquires no better adaptation to altered circumstances of locomotion than is derived from the mere thickening of the remaining digits. The relation between the carpal and tarsal bones, and the remaining two metacarpal and metatarsals, remains unaltered, and the remaining digits do *not* enter into any modification by which they can receive more ample support from the carpal and tarsal bones, by taking the place formerly occupied by the reduced digits. *Anoplotherium*, *Liphodon*, and *Hyopotamus*, are examples of this method of reduction.

In the second or *adaptive* method of reduction, the middle digits grow larger and thicker than in the first mode; but while broadening transversely they do not adhere to the ancestral type, but tend to gain a support on *all* the bones of the carpus and tarsus, pushing the lateral digits to the side and thereby gaining a better and more complete support for the body. The lateral digits, being rendered useless, tend to disappear, and the remaining digits, being pressed from both sides by the carpal and tarsal bones, tend to coalesce to form the *canon* bone of recent ruminants, or of the hind foot of *Dicotyles*. In this, the *adaptive* method, modification keeps pace with inheritance, and examples of it may be seen in *Sus*, *Dicotyles*, *Hyæmoschus*, and the Ruminants.

All extinct Paridigitata follow the first or *inadaptive* mode of reduction, whilst all living genera follow the second. Did the former not become extinct because of their incapacity to adapt themselves to altered circumstances, and the latter survive from being able to adapt themselves more fully to those circumstances? From an examination of fossil remains, it is found that the Paridigitates, of the genus Hyopotamus, were Selenodonta of the *inadaptive* line of descent, inheritance in them being stronger than modification. Among the Bunodonta following the *inadaptive* method, the old representatives are but little known, *Listriodon* and *Elotherium* being the most certain, and the latter apparently didactylate.

Following the adaptive method, among the Selenodonta are *Chœrotherium*, *Palæochœrus*, and the Swine, and the culminating or most reduced stage is not yet reached among the *Suina*, but it is certainly the direction in which they tend. Among the Bunodonta there is great difficulty in tracing the line of descent whence originate the Ruminantia. From the existence of *Hyæmoschus* we may predict that they were originally tetradactylate, and there are many other intermediate condi ions, as *Tragulus* and *Gelocus*.

"Magnetic Survey of Belgium in 1871." By Rev. S. J. Perry. The magnetic observations which furnished the results contained in this paper were made during the Autumn months of 1871.

The instruments used and the methods adopted were almost identical with those employed in previous magnetic surveys of France.

The dip was observed by Mr. W. Carlisle, magnetic assistant of Stonyhurst Observatory, and the rest of the observations were taken by the Rev. S. J. Perry.

This new series of determinations of the terrestrial magnetic elements was rendered the more necessary, as preceding observers had chosen very few stations in Belgium, and as the curvature of the isodynamics and isoclinals in Dr. Lamont's maps of Belgium, Holland, and North-west Germany, indicated a very considerable disturbing cause in the first-named country.

The values obtained in 1871 are a strong confirmation of the suspicions of irregularity, to which former observations had given rise. For although the lines of equal dip, declination, and horizontal force bear a sufficiently close resemblance to those of neighbouring countries, there is evidence of much disturbance; and when the valves of the dip and horizontal force are combined, the isodynamics show clearly that the coal-measures, which stretch completely across the south east portion of Belgium, exercise a strong disturbing influence. This local magnetism might be incapable of producing more than a decided curvature of the isodynamics of an extended tract of country; but when all the stations of observation are situated within narrow limits, the perturbation completely masks the normal direction of the lines.

The following is a complete list of the magnetic elements observed at the different stations, and reduced to the common epoch of January 1, 1872.

Station.	Declination. °	Dip. °	Horizontal force.	Intensity.
Aix-la-Chapelle..	16·464	66·637	4·0064	10·1025
Alost	17·349	67·210	3·9518	10·2016
Antwerp	17·489	66·999	3·9296	10·0559
Arlon	16·398	65·907	4·1175	10·0857
Bruges	17·938	67·155	3·8950	10·0321
Brussels	17·959	66·975	3·9613	10·1271
Courtray	17·756	66·678	4·0028	10·1103
Ghent	17·823	67·221	3·9197	10·1232
Liége	16·233	66·464	4·0145	10·0522
Lierre	—	66·948	—	—
Louvain	16·824	66·898	3·9565	10·0828
Mechlin	—	66·714	—	—
Mons	17·216	66·573	4·0065	10·0767
Namur	17·541	66·538	3·9941	10·0311
Ostend	18·097	67·211	3·9152	10·1077
Spa	16·627	66·653	4·0239	10·1531
Tournay	17·691	66·632	3·9975	10·0776
Tronchiennes	17·867	67·361	3·9032	10·1397
Turnhout	17·025	66·113	3·9542	10·1665
Verviers	—	66·718	—	—
Secular variation	−0·1255	−0·0573	+0·00542	−0·01155

Zoological Society of London, February 4.—Professor Huxley, F.R.S., V.P., in the chair.—A letter was read from Mr. Henry W. Piers, late acting curator of the South African Museum, Capetown, containing remarks on a specimen of the *Chimæra australis*.—Mr. E. Blyth exhibited and made remarks on some Tiger Skins from India, Burmah and Siberia.—A communication was read from Mr. R. Meldola, containing remarks on a certain class of cases of variable protective colouring in insects.—A communication was read from Mr. G. Gulliver, F.R.S., containing a series of measurements of the Red Blood Corpuscles of various Batrachians.—A paper was read by Dr. A. Günther, F.R.S., containing an account of certain species of Reptiles and Batrachians, obtained by Dr. A. B. Meyer in Celebes and the Philippine Islands.—A communication was read from Mr. A. G. Butler, containing a monographic revision of the genera *Zephronia* and *Sphærotherium* of the sub-order Myriopoda, together with descriptions of some new species of these genera.—A communication was read from Mr. G. French Angus, containing descriptions of eight species of Land and Marine Shells from various localities.—Messrs. P. L. Sclater and Osbert Salvin read the sixth of a series of papers on Peruvian Birds, collected by Mr. H. Whitely, in the Andes of Peru. The present communication contained an account of eighty species, collected principally at Cosnipetz, in the province of Cuzco.—A communication was read from Mr. H. Whitely, containing notes on the Humming Birds collected and observed by him in the Andes of Peru.—A communication was read from Dr. J. E. Gray, F.R.S., on the genus *Ocadia*, which he considered should be referred to the family *Bataguridæ*.

Chemical Society, February 6.—Dr. Williamson, F.R.S., vice-president, in the chair.—A communication was made by Dr. H. E. Armstrong "On the action of Sodium on Aniline."—A paper on "Anthrapurpurine," by Mr. W. H. Perkin, was then read by the author. Anthrapurpurine is a colouring matter which accompanies alizarine in the crude "artificial alizarine," now so largely manufactured and employed in dyeing instead of madder. Like alizarine it is capable of imparting brilliant and fast colours to cloth mordanted with alumina or iron.—A paper was also read by Dr. C. R A. Wright on "Isomerism in the terpene family of hydrocarbons." In it he gives an account of his experiments with oil of nutmegs and oil of orange-peel.

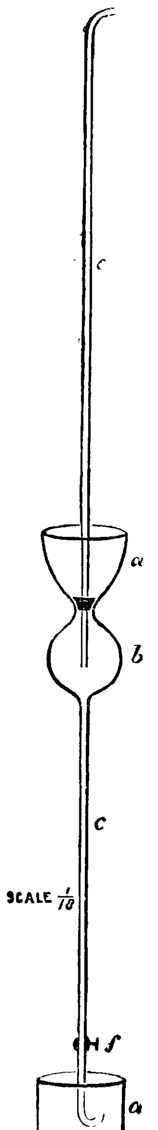
Anthropological Institute, Feb. 4.—Col. A. Lane Fox, vice-president, in the chair.—Mr. W L. Distant read a paper on the inhabitants of Car Nicobar." The people of Car Nicobar are taller than the average Malay, and darker in the colour of the skin. Their faith in a good spirit is slight, and in an evil spirit, which is invested with a personality, is strong. Their honesty is so well known that traders at once deliver their stores on the promise of these islanders to pay the necessary number of cocoanuts in return; and the promise is always fulfilled. They take but one wife, and adultery is severely punished.—A paper by Mr. J. E. Calder was read on the extirpation of the native tribes of Tasmania." The author who had had the advantage of above forty years' experience of the Tasmanians, entered very fully into their physical and mental characteristics, habits, customs, and modes of warfare, and the causes which led to the rapid extinction of all the tribes. They were intelligent, capable of considerable culture, and showed every disposition to become civilised; but the abundant supply of food induced indolence, which, together with the sudden and violent change of habit from savage to civilised life was one of the chief causes of extinction. The chairman announced the appointment of a Committee of Psychological Research.

Entomological Society, January 27, Annual Meeting.—Professor Westwood, president, in the chair. Statement of treasurer's account for 1872 read, and report of council.—Professor Westwood was re-elected as president for 1873, Messrs. S. S. Saunders, G. H. Verrall, C. O. Waterhouse and J J. Weir, new members of council; Mr. McLachlan as treasurer; Messrs. F Grut and G. H. Verrall, secretaries, and Mr. E. W. Janson as librarian.— he president delivered an address on the progress of entomology during the past year.

Geologists' Association, Feb. 7.—The Rev. T Wiltshire, M.A., the retiring president, in the chair.—Henry Woodward, F.G.S., was elected president for 1873; and Robert Etheridge, F.R.S., Prof. Morris, F.G.S., James Thorne, F.S.A., and the Rev. T. Wiltshire, M.A., vice-presidents. Messrs. W Hislop, J. L. Lobley, and A. Bott were re-elected treasurer, honorary secretary, and honorary librarian respectively. The report for the year 1872 shows the association to be in a flourishing state, and was unanimously adopted.

MANCHESTER

Literary and Philosophical Society, Dec. 24, 1872.—The president, Dr. J. P. Joule, F.R.S., drew attention to the increasing number of cases of hydrophobia. There was every reason for believing that this dreadful disorder was communicated from one animal to another by a bite, and seldom, if ever, was spontaneously developed. Inasmuch therefore as the effects of a bite nearly always occurred within four months, it would only be necessary to isolate all dogs for that period in order to stamp out the disease. That was the opinion of Dr. Bardsley, whose elaborate paper will be found in the fourth volume of the Memoirs of the Society, and probably gave rise to the practice of confining dogs at certain periods of the year, which has unfortunately been rendered to a great extent nugatory in consequence of having been only partially adopted.



Jan. 7.—The president referred to the great loss which the Society had experienced by the death of one of its most distinguished honorary members, Dr. Rankine; called away in the prime of life, his loss is one of the most severe that could have befallen science.—Mr. William H. Johnson called attention to the action of sulphuric and hydrochloric acids on iron and steel. If after immersion for say ten minutes in either of these acids a piece of iron or steel be tested, its tensile strength and resistance to torsion will be found to have diminished. Exposure to the air for several days, or gentle heat will, however, completely restore its original strength. Prolonged immersion in acid has a tendency to produce a crystalline structure in even the best wrought iron.

January 21.—The president explained a simple apparatus by means of which a very high degree of rarefaction of air could be produced with much facility, and which might in some circumstances be found preferable to the common air-pump or even the Sprengel. It consists of a glass funnel *a* surmounting a globe *b*, from the lower part of which a tube *c* descends to a jar of mercury *d*. The tube *e*, in connection with the receiver to be exhausted, is furnished with a vulcanised india-rubber plug which fits into the neck of the funnel. In using the apparatus the stopcock *f* is shut and the funnel filled with mercury. Then by lifting the tube *e* with its plug, the mercury fills the globe *b* and the pipe *c*. The tube *e* is then replaced, and the stop-cock being opened, the mercury descends in *c*, emptying the globe. By returning the mercury into the funnel by means of a pump, or more simply, by lifting the jar *d*, the process is repeated until the requisite degree of rarefaction is produced.

PARIS

Academy of Sciences, Jan. 27.—M. de Quatrefages, president, in the chair.—M. A. Trecul read the second part of his paper on the carpellary theory of the Papaveraceæ. This portion of the paper treats of *Glaucium* and *Eschscholtzia*.—M. Boussingault read a note on alimentary substances preserved by cold. The author exposed several articles of food to a temperature of − 20° for several hours in closed flasks; this was in 1865. The substances are now perfectly sound and free from putrefaction. M. Th. Lestiboudois read the continuation of his paper on the structure of the *Heterogene*.—M. Marès read a note on the vine sickness characterised by Phylloxera. The paper was referred to the commission on that subject.—A letter from M. I. Pierre on the determination of the boiling point of liquid sulphurous anhydride was then read. The method consists in introducing a thermometer, through a pierced cork, into a thin tube containing the anhydride. Another hole in the cork holds an exit tube; the apparatus is then suspended in the air, the SO_2 begins to boil, and the thermometer is then read. M. Faye presented M. Heis's "Atlas cœlestis novus," and made some quotations from it on the number of stars visible to the naked eye; the author can see many stars put down by other astronomers as of the 7th or 8th magnitude.—M. L. d'Henry read a paper on the use of the mono-chromatic sodium light in observing the tints of litmus in alcalimetry. The author finds that this reaction is much more easily seen by the yellow light.—M. Ch. Valson sent a note on the modulus of refrigerating power in saline solutions.—MM. C. Friedel and R. D. Silva sent a note on a new tertiary alcohol, &c.; M. H. Joulie a note on the commercial estimation of nitrates; and MM. Gayon one on the spontaneous alteration of eggs: the author finds the putrid eggs full of vibriones; he intends to seek for the origin of these bodies.—M. Gréyhant sent a note on the estimation of carbonic oxide combined with hæmoglobin.—M. F. Pisani sent a paper on the analysis of Jeffersonite from New Jersey, and on the analysis of Arite from Mount Ar (Basses Pyrénées).—M. S. Chautrain sent a paper on the reproduction of eyes in the crayfish. The author has cut out the eyes of the crustacean, and finds that they grow again in about eleven months.

DIARY

THURSDAY, FEBRUARY 13.

ROYAL SOCIETY, at 8.30.—On Curvature and Orthogonal Surfaces: Prof. Cayley.—On a New Relation between Heat and Electricity: Prof. Guthrie

SOCIETY OF ANTIQUARIES, at 8.30.—On a Brass Bowl of the 12th century: T. A. Gardiner.—On Early Deeds and Charters: R. H. Wood.

MATHEMATICAL SOCIETY, at 8.—On Systems of Linear Congruences: Prof. H. J. S. Smith.—Application of the Hodograph to the Solution of Problems on Projectiles: J. Macleod.

FRIDAY, FEBRUARY 14.

ASTRONOMICAL SOCIETY, at 8.—Anniversary.

ROYAL INSTITUTION, at 9.—On Recent Progress in Weather Knowledge: R. H. Scott.

QUEKETT CLUB, at 8.

SATURDAY, FEBRUARY 15.

ROYAL INSTITUTION, at 3.—Comparative Politics: Dr. E. A. Freeman.

SUNDAY, FEBRUARY 16.

SUNDAY LECTURE SOCIETY, at 4.—Pre-Historic Fortifications: Lawson Tait.

MONDAY, FEBRUARY 17.

LONDON INSTITUTION, at 4.—Physical Geography: Prof. Duncan.

ENTOMOLOGICAL SOCIETY, at 7.

ASIATIC SOCIETY, at 3.

COLLEGE OF SURGEONS, at 4.—Osteology and Dentition of Extinct Mammalia, with their Geological and Geographical Distribution, &c.: Prof. Flower (Hunterian Lectures)

TUESDAY, FEBRUARY 18.

ANTHROPOLOGICAL INSTITUTE, at 8.—Note on the Macas Indians: Sir John Lubbock, Bart.—On the Relation of the Parish Boundaries in the South East of England to Great Physical Features: William Topley.

ZOOLOGICAL SOCIETY, at 8.30.—Report on the Hydroida collected during the Expeditions of H.M.S. Porcupine: Prof. G. J. Allman.—On Œgithognathous Birds: W. K. Parker.—Notes on the Anatomy of the Binturong (*Arctictis binturong*): A. H. Garrod.

ROYAL INSTITUTION, at 3.—Forces and Motions of the Body: Prof. Rutherford.

WEDNESDAY, FEBRUARY 19.

SOCIETY OF ARTS, at 8.

METEOROLOGICAL SOCIETY, at 7.—Description of an Electrical Self-registrating Anemometer and Rain-gauge: Fenwick W. Stow.—On the Madras Cyclone of May 2, 1872: Capt. H. Toynbee.—On the Character of the Storm of August 21–23, 1868, over the British Isles: Capt. T. O. Watson.—On some Results of Meteorological Telegraphy: Robert H. Scott.

LONDON INSTITUTION, at 7.—Paper and Discussion.

COLLEGE OF SURGEONS, at 4.—Hunterian Lectures.

BOOKS RECEIVED

ENGLISH.—On the Miracle recorded in Joshua x.: Rev. E. Biley (Hatchard).—Lessons on Elementary Anatomy: St. G. Mivart (Macmillan).

FOREIGN.—Annuaire de l'Academie Royale de Belgique, 1873.—Lehrbuch der Physik: 2nd part, 1873.—Fauna der Kieler Bucht, vol. ii.: H. A. Mayer and R. Robins (Englemann: Leipzig).

CONTENTS

ERRATUM.—No. 171, p. 275, 1st col., line 7 from bottom: for "boiled *Bacteria*" read "living *Bacteria*."