THURSDAY, APRIL 4, 1872

THE FOUNDATION OF ZOOLOGICAL STATIONS

II.—The Aquarium at Naples

WHEN I wrote the first article on the "The Foundation of Zoological Stations,"* I desired to bring before the general public the idea of extending the principle of co-operation in Science in general, and in Biology in particular. I now propose to give a sketch of the internal organisation of a zoological station as it presents itself to my mind. It is natural that in doing this I give more or less a picture of what I intend to produce at the station which is at present being erected under my superintendence at Naples.

The building occupies an area of 7,000 square feet, and is situated at a very short distance—100ft.—from the sea. It forms a rectangle 100ft. long and 70ft. broad, with a height of 40ft. The building is divided into two parts, the lower part being occupied by the tanks of the great aquarium, which is to be open to the public; the upper part containing twenty-four rooms of different sizes for laboratories, a library, and collections, and for lodging the three or four zoologists who will be constantly occupied in managing the station.

I will not speak here of the manner in which the technical parts of the aquarium are to be arranged, as this would scarcely interest my readers. What I should like to specialise a little relates more to the facilities for scientific study which the station will afford.

Let me speak first of the lower part of the building, the great public aquarium. It will contain fifty-three tanks of different sizes, one of them 32ft. long, 10ft. broad, and 3ft. to 6ft. deep; twenty-six 6ft. 6in. long, and equally broad; and twenty-six others 3ft. long and 3ft. to 6ft. broad. These tanks will contain marine animals of all kinds, either isolated or more or less mixed, according to the investigations that are to be made.

I imagine now that in one of these tanks a number of Medusæ and Salpæ are together, and the problem is to know how they will behave in so close a union. This can be solved only in such a tank, and it will be a very easy study, as the naturalist has only to occupy a movable chair, which is placed before the tank, and which hides him and the tank by special precautions completely from the general public. At a certain moment you can put into the tank some rapacious fishes, or some of the swift and warlike Crustaceans of the Palæmon tribe, and wait for the movements and actions of the Medusæ as well as the Salpæ. You may repeat these observations, and add other different species; and if you have patience enough, you cannot fail to discover facts about the general habits of the animals in question, and the functions of their organs, which were unknown before, and which may yield, perhaps, valuable arguments to establish a theory on the manner in which they originated from other animals. As it is, we hardly know anything about the life of Medusæ or Salpæ, and our ignorance of the habits of other marine animals is equally great.

* Nature, vol. v. p. 277.

Let us take another example. I was present when half a dozen stone crabs (*Lithodes Maya*) were brought from Norway to the Hamburg Aquarium. Mr. Lloyd, at that time the Director of the Aquarium, distributed them in several tanks. It happened that one of them found itself in company with a number of *Crerilabrus norwegicus*. a swift and clever little fish. These at once began to attack their new companion. With considerable skill they tried to hurt the eyes of the crab, which on their long stalks presented, of course, the most vulnerable part of the clumsy and spinous animal. After half an hour's continued attacks the fishes actually succeeded in tearing out one of the eyes. This fact made me investigate at once the mode of protection with which Nature had furnished the eyes of Crustacea, and I collected a considerable number of observations, which, if completed and worked out, would possibly form a very interesting chapter in our knowledge of the progress of Natural Selection.

I shall adduce a third instance for the necessity of facilitating observations of this kind. In his excellent refutation of some of Mr. Mivart's objections to the theory of Natural Selection, Mr. Darwin relates ("Origin of Species," 6th Edition, p. 186) some observations made by Malm on the way in which the eyes of the Pleuronectes get both on one side of fish. The following are his words:—

"The Pleuronectidæ, whilst very young and still symmetrical, with their eyes standing on opposite sides of the head, cannot long retain a vertical position, owing to the excessive depth of their bodies, the small size of their lateral fins, and to their being destitute of a swim-bladder. Hence, soon growing tired, they fall to the bottom on one side. Whilst thus at rest they often twist, as Malm observed, the lower eye upwards, to see above them; and they do this so vigorously that the eye is pressed hard against the upper part of the orbit. The forehead between the eyes consequently becomes, as could be plainly seen, temporarily contracted in breadth. On one occasion Malm saw a young fish raise and depress the lower eye through an angular distance of about seventy degrees. We should remember that the skull at this early age is cartilaginous and flexible, so that it readily yields to muscular action. Besides, Malm states that the newly-hatched young of perches, salmon, and several other symmetrical fishes, have the habit of occasionally resting on one side at the bottom; and he has observed that they often then strain their lower eyes so as to look upwards; and their skulls are thus rendered rather crooked. These fishes, however, are soon able to hold themselves in a vertical position, and no permanent effect is thus produced. With the Pleuronectidæ, on the other hand, the older they grow the more habitually they rest on one side, owing to the increasing flatness of their bodies, and a permanent effect is thus produced on the form of the head and on the position of the eyes."

I think observations of this kind ought to speak so much in favour of a great observatory for marine animals, that it would be superfluous to add any more instances for its necessity. I hope the Naples Institution will rapidly produce a great number of similar observations, and thus render one of the most important services to the still utterly neglected knowledge of the animal life of the ocean.

Let us now ascend the staircase from the lower part of the future Zoological Station to the upper floor. We pass through a series of rooms on the north side, the first of which is occupied by the chief zoologist. Before the window a table for microscopical work is placed, surrounded by small tanks for breeding eggs and keeping alive larvæ and other smaller animals. Each tank is furnished with a continuous current of fresh sea-water, which can be weakened or strengthened, or completely stopped, as it pleases the zoologist. The rest of the room is reserved for the business matters of the station. Next to it comes the library-room, large enough to keep a library of 25,000 volumes. Two tables for microscopical work placed near one another occupy the place near the window, some tanks of different sizes, completely furnished with tubes, &c., are placed at the disposal of those who occupy the tables. Next follows the great laboratory. In the centre of the room we find at least twenty to thirty tanks of different sizes, each of them with its own current of sea-water; the two great front windows afford light for four working tables placed near them. The walls may be occupied by physiological instruments and by other apparatus which will be required. Galleries on the walls and across the centre of the room yield enough space for placing all sorts of collections and other things on them without hindering the free passage in the laboratory. The last room on this northern side will be occupied by the first assistant zoologist, and be furnished, like that of the chief zoologist, with working table and tanks. Both the corners of the house are occupied by towers, and these towers contain two small chambers of nine feet square; they are also to be furnished with tables and some tanks, so that in all ten zoologists may, at the same time, find complete accommodation for their work.

The south side of the upper part of the station will be occupied by four rooms, sufficiently large to allow the collections to increase for many years, and the laboratory to take possession of double the space it will occupy at the beginning. The west and east side afford some private rooms for the use of the naturalists employed in the management of the station. Under the roof eight other smaller rooms complete the whole disposition of the space inside the building.

Now let me say some words on the functions these organs of the Zoological Station are to exhibit in future. There are first to be noticed the great advantages which will be offered to the single student. Whoever works with marine animals will be painfully acquainted with the difficulty of preserving them alive longer than two or four days. They almost invariably die, and decompose very soon. If one now considers that anatomical and stil more embryological problems are only to be solved during weeks or months of undisturbed and indefatigable exertion, it is quite evident what enormous advantage must result from the possibility of keeping these animals alive during weeks. And this will be effected by the help of tanks with a continuous stream of sea-water. The sea being always in motion, caused either by the waves or still more by the vast number of currents, makes the constant alternation of fresh and aërated sea-water necessary for the life of the animals. The imitation of these currents and the artificial injection of air into the tanks will render it possible to keep even embryos and larvæ alive, which formerly could never be studied on account of their early death.

Besides, everybody knows how often fishermen bring eggs or larvæ which are completely unknown to the zoologist. They are, perhaps, highly interesting; perhaps belonging to animals whose eggs have never been seen before, as they deposit them far off in the open sea or on the bottom. The single zoologist in his small room in a Naples Hotel, with some bottles or basins at his disposal, puts them into a tumbler, changes the water regularly, and thus succeeds in keeping them alive for a week, but he forgets the changing once, and to-morrow they are dead. A good many will even not live in spite of the changing of the water, because they require the constant stream running over them. The single zoologist in the station, on the other hand, puts them into a tank, sets the stream in motion, and has nothing to do but to watch their development, and the final disclosure of the embryo, or the metamorphoses of the larvæ, and may completely succeed in getting a key to their nature and their relation to other animals.

Considering now the all-importance of embryology and development in the present state of zoology, it is easy to recognise in the continuous stream of the sea-water in the station a fundamental novelty in the conditions for the progress of scientific zoology. Go a little further. It is rarely advisable to work with one subject alone when on the sea-coast. There are so many incidents that change the conditions of the work you have in hand, that you are much wiser to have, whilst working at one chief problem, one or two smaller ones with it. But chance is often a paradoxical thing; it will entirely inundate you one day with excellent material for all these problems, and cause you great embarrassment as to what to take first; and another day it will yield you nothing whatever, so as to force you to idleness. Now again with a series of tanks and streaming sea-water you can pursue everything quite at your leisure, stop one investigation when you like, or take up another, or drop them both, and work for one day with some interesting novelty, without being afraid of spoiling the material of the old objects, and losing the opportunity of getting through it. And everybody knows what a consolation it is to be always capable of taking your principal line of work up again, whilst you are not forced to deny yourself the chance of taking some notice of new arrivals, if it even were only for a little instructive side glance of some hours.

These are some illustrations of the great facilities and advantages of the station, yielding thus in future to scientific workers immense economy of time, money, and power. But this is not all that the station will do. Every well-instructed biologist is aware of the great step anatomical science made when first Cuvier created and afterwards Johannes Müller reformed Comparative Anatomy. The description of the different types, the organs and their homologies, their histological constitution, similarity and dissimilarity, became well worked out, and extended the range of our insight over almost all living animals.

Physiology ought to have gone the same length, following exactly the lines of anatomical research, to tell us something about the functions of all the organs and structures through the whole range of animal life. But physiology did not do so; it got into another line, investigating with the utmost care, and also with splendid success, the nervous functions of the higher vertebrates, developing theories on the physical agency of these functions, and trying to verify these theories by experiments. It went also into chemical researches, trying to get clear insight into the chemical processes of digestion and the nourishment of the body of the higher vertebrates. In consequence of this one- or rather two-sidedness, it has happened that physiology appears to be very indifferent to the great overthrow of our views regarding the organic world, caused by the doctrine of evolution. Indeed, celebrated physiologists even go so far as to deny the truth of that doctrine altogether. Now nothing can be a stronger proof that there is something amiss in the state of physiology, and this something consists in the complete want of Comparative Physiology. If we cannot understand the anatomical constitution of men and the higher animals without the study of comparative anatomy and embryology, we can equally as little understand their physiological components if we do not follow them up through the whole series of animal life. It is utterly deplorable that so very little has been done in this immense department of Science. What do we know of the functions of such all-important organs as the so-called segmental organs of Annelids, which in the further development of other classes of the animal kingdom grew into some possessing the highest functions? Nobody doubts that Amphioxus is a Vertebrate; but has any one yet tried to make physiological experiments with that animal, though it is one of the most hard-living of all marine animals? And is there in any way a base laid for the physiology of fishes, which must yield results of the utmost importance? Does the academical physiology of modern times do the least to unveil the mysteries of generation, of growth, of degeneration? Are these departments, perhaps, less interesting, less important, less accessible than Nervous Physiology or the Physiology of Digestion? There is apparently a lack of idea in this great department of Biology, an overgrowing influence of Physicists, and a want of morphological knowledge among Physiologists. What would have been the fate of Physiology if, unfortunately, Johannes Müller had not died in the same year when the "Origin of Species" came out? He was the man to create at once the study of Comparative Physiology, and his spirit must again come over physiologists to enable them to perceive the immense field of action before them, and the neglect with which they treat it.

Now, I can only say that it is one of the great objects of the Naples station to do all in its power to carry on a fair commencement of Comparative Physiology. Whatever money may be spared, whatever pains bestowed, it will willingly be given to so important a duty, and it would be considered a great good fortune should a thoroughly instructed physiologist make up his mind to accept a post in the station in order to establish and carry on a Physiological Laboratory.

To all the possible advantages of the station for the intermittent action of single naturalists alluded to above, unite now the great advantage from the fact that such isolated action will be quite superseded. A station like that of Naples wants at least three well-trained zoologists to conduct it properly. One of the greatest privileges for these zoologists will certainly be that teaching forms no essential part of their duties. Whoever knows by experience what a loss of energy and of time is caused to all those original workers who are bound to teach daily on elementary topics, what great relief vacations form in the life of university professors and privat-docents (who generally proceed with original work daily during their vacations), will be aware of the exceeding value of paid places where teaching is no necessity, and is only admitted for single and special puposes. The comfortable system of English fellowships, granting money to young gentlemen who are supposed to merit special rewards by having undergone some examinations, will, in fact, be united to the principle of Continental academies, of paying men of scientific reputation, that they may go on at their leisure with original scientific work. The zoologists in the stations will be selected from the number of young professors or privat-docents, who, as a matter of course, are supposed to be ambitious to do some good things in science, even at the risk of sacrificing comfort and agreeable social life. They will be sufficiently paid, and their payment even raised so as to equal that of a moderately-paid German university professor; though perhaps not approaching the level of the payment of a young Oxford or Cambridge Fellow. Nevertheless, they will be put in a position to balance that inferiority by making themselves known as workers, and adding to the storehouse of science facts and observations which may secure to them, if not a comfortable position in life, yet at least applause and respect from the eminent men of their science.

And these zoologists, having at their disposal a laboratory of the perfection and extent of the future Naples one, being aided by the possession of an all but complete biological library, and having before their doors the immense storehouse of the Mediterranean Sea, cannot fail to effect a great step in organising the progress of biological work. Let us suppose the question arose whether Cephalopods preceded in geological time other Molluscs, or were a higher developed offspring of them. The problem would be completely insoluble to University zoologists. But the three zoologists of the station at Naples would at once proceed with a solution in working out the embryology of the seven or eight species occurring in the Gulf, communicating and controlling each other's observations and conclusions. Some foreign zoologists might join their labours for half a year, and Science would be at once in possession of some thoroughly worked out contributions to the Comparative Embryology of the Cephalopods. Apply the same system of co-operation to other problems, for instance to one the solution of which is so much longed for, as the Embryology of Sharks. Years will not enable a single worker to go through that enormous task, with the sole aid of his individual opportunities. But suppose the leading zoologist of the station got the plan into his head to carry out the solution of this problem. He invites some excellent zoologist who completely understands the problem to come to Naples, to bring with him two or three assistants who have already beforehand been made acquainted with the object of the inquiry and the chief difficulties of the observation, and to set to work from the very first day of their arrival. He himself will do all in his power to procure every day fresh material of all kinds ; by the help of the small steam yacht of the station he may succeed in carrying over to the station sharks which were taken two hours before, so as to secure the life of the embryos without any danger of destruction. Then he can isolate and feed them, and make them live as long as he wants. Any one who knows the fauna of the Mediterranean knows also what a large number of different species of rays and sharks arrive in it, and all these could be readily placed at the disposal of the embryologists, thus enabling them to overcome at once immense difficulties which have hitherto been almost completely unassailable.

The station will have several people, fishermen or guards, who by-and-by will be completely acquainted with the fauna of the bay, and will be able to collect whatever is necessary. As very often rare or much-wanted animals come in with some current in great quantities and disappear even the next day, such animals may at once be taken in great numbers and distributed through a great number of tanks, so as to keep them alive for future time.

Very often zoologists from the Universities have just four or six weeks' leisure, and would very much like to do some original work on the shores of the Mediterranean. But to go there for so short a period, to lose so much time in getting up all the necessary arrangements, and spend so much money for so small and uncertain scientific profit, is rather inadvisable for those who have to live on small incomes. But suppose the station is ready, zoologists announce some weeks beforehand their intention to come to Naples, and to work with this or that object, what is easier and what more comfortable than to arrive at the fixed date, to find lodging, laboratory, library, and material all ready and in the very best state, and to go over a ground of scientific work in six weeks, which otherwise would, perhaps, have occupied three months.

And will not the establishment of the Naples Station enable even those to come and work there, who (like many of the very best German and foreign zoologists) do not command means large enough even for a stay of two or three months at their own expense ? Will not the constant presence and the collected experience of the station-zoologists save the foreign naturalists all the trouble and annoyance which inevitably result to every one who is not well acquainted with the ways and modes of life and customs of a place so complicated, and in every way so strange, as Naples ? And, on the other side, will not the presence of the three station zoologists guarantee Science that it shall not lose the fruits of all that work which was begun but could not be finished by foreign zoologists, since their teaching duties forced them to go home and leave it uncompleted behind? Easily enough one of the station zoologists takes it up and carries it on to a point where it may be fit for publication, thus preserving the labour and energy spent on it.

But I could continue preaching and preaching on a chapter which ought to be clear to every one who understands the progress of Science. I trust that what has been said is sufficient to procure the assistance of all those who think it a pity that whilst millions and millions are accumulated for the pleasure of individuals who very often do not care a bit for the welfare or the progress of their fellow creatures, schemes like the present, so evidently adapted for throwing open new lines of inquiry into the mystery of the universe, and by that means adding to human progress and happiness, should be abandoned to chance and to isolated individual goodwill and effort.

Naples, March 9 ANTON DOHRN

SCROPE ON VOLCANOS

Volcanos. By G. Poulett Scrope, F.R.S., &c. Second Edition revised and enlarged. With Prefatory Remarks. (London : Longmans, 1872.)

THE subject of volcanos is one which possesses a popular as well as a purely scientific interest, and the more so of late years, since it seldom happens that the foreign mails come in without bringing us tidings of volcanic outbursts or earthquake shocks, often fearfully disastrous, which have occurred in some one or other part of the globe ; so that it is but natural to expect that the appearance of a revised and enlarged reissue of the second edition of the well-known work on volcanos by the distinguished and veteran geologist Mr. Poulett Scrope, will attract the attention, not only of geologists, but of the scientifically inclined public in general.

It is not saying too much, when we express our opinion that no geological library can be considered complete without Mr. Poulett Scrope's work ; but at the same time it is fairly open to question as to whether this volume in its present form can in 1872 be regarded as an improvement upon what it was before in 1862 ; since, with the exception of a list of the earthquakes and volcanic eruptions which have occurred since the year 1860, the additional matter, introduced into it as a sort of postscriptum preface, is of a purely discursive and theoretical character, and for various reasons not likely to meet with that general acceptance, from those posted up to date in the subject, which the mass of excellent observational and descriptive matter embodied in the book itself is fully entitled to.

To render full justice to Mr. Poulett Scrope as a vulcanologist, we must, however, carry ourselves back nearly half a century, to the time when the first edition of this work appeared in print ; for it is only by so doing that we can be enabled to thoroughly appreciate the importance of his labours in the study of these wonderful phenomena, or to understand how largely they contributed to bring about the substitution of sounder doctrines concerning the formation and structure of volcanos, instead of the very erroneous, yet all but universally received hypotheses, which at that time were taught in the schools of natural science.

If now we proceed to analyse the contents of the volume before us, its perusal will soon show that it devotes itself exclusively to the consideration of the subject treated only from a purely physical and geographical point of view, and as such, it must be admitted to be a most elaborate digest of what is known relating to what may be termed the mechanics of volcanos, their physical structure, and their local distribution over the surface of the earth; whilst at the same time the very excellent descriptions of the phenomena attendant on volcanic outbursts in their different phases, and the building up of cones and mountain chains, are of the greatest value to the student, and the more so from their being, in many instances, founded upon the personal experiences of the author, whose accuracy as an observer in the field can only be fully appreciated by those who, like the writer of this notice, have had an opportunity of following in his footsteps, and examining on the spot localities which Mr. Poulett Scrope has so well described in his memoirs.

In the present volume, the illustrations which are so necessary to a work of this character are not only ample, but are in many instances particularly well selected, so as to express exactly what the author intends to convey. As an example, the following woodcuts, Figs. 1 and 2, borrowed from page 31 of the volume, which represent, in elevation and plan, the volcanic Island of Stromboli, or so-called Lighthouse of the Mediterranean, convey to the mind at a glance the main features of a volcanic cone with its crater, of which, as is so common, the one side of the lip has given way. We may also refer especially to two other woodcuts, Figs. 60 and 61, page 232, as an instance of the extremely happy way in which a comparison is made visible to the eye between the principal features of a region of terrestrial volcanic activity, and those of a portion of the visible surface of the moon, in order to point out in the words of the author (p. 231) that "the analogy is so close, that it is impossible for a moment to doubt the volcanic character of the lunar enveloping crust."

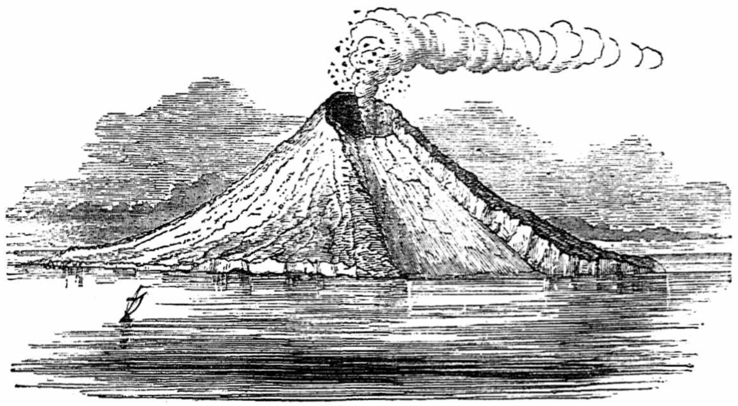

FIG. 1.—VIEW OF STROMBOLI, FROM THE NORTH

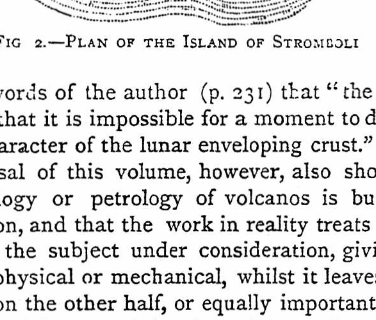

FIG 2.—PLAN OF THE ISLAND OF STROMBOLI

The perusal of this volume, however, also shows that the mineralogy or petrology of volcanos is but barely touched upon, and that the work in reality treats only of one half of the subject under consideration, giving only the purely physical or mechanical, whilst it leaves out of consideration the other half, or equally important chemical one, in which so much has been done during the last twenty years, and without the due consideration of which, it is self-evident that no confidence can or ought to be placed in conclusions drawn as to the causes, probable seat of, or many other questions relating to volcanic action, or to the nature of the interior of the earth itself, which is so intimately connected therewith; and it is on this account that we have purposely abstained in the present notice from criticising the theoretical views and deductions of the author.

In conclusion, whilst we, for the reasons before mentioned, heartily recommend Mr. Poulett Scrope's "Volcanos" to the mature consideration of every English student in this branch of geology, we at the same time advise that it should be studied in connection with the admirable memoirs of Bunsen, v. Waltershausen, and others, which have of late years thrown so much light upon the nature of volcanic phenomena, in order that by making himself conversant with the two great forces in Nature, physical and chemical, he may be the better enabled to arrive at sound conclusions.

DAVID FORBES

OUR BOOK SHELF

Quarterly Weather Report of the Meteorological Office. Part III. July to September 1870. (Stanford, 1872.)

THIS, the new number of the *Quarterly Weather Report*, is in point of care the equal, in some minor details of execution the superior, of all former numbers. The method of showing the wind's velocity by a shaded curve, which has been adopted since the first part of this series, adds much to the ease with which the graphic representation can be read, and is a decided improvement; so is the introduction into the margin of the miniature charts of barometric pressure during strong winds. The engraving too is clearer and finer than in some of the past numbers, and is perhaps as nearly perfect as can be. After a few years the accumulated numbers of these reports will form a most valuable record. There are many students of meteorology still impressed with the idea that, with a correct knowledge of what has been, we may be able to form an opinion of what is to be. It seems to us by no means improbable that with more accurate information, such as this now being stored for future use, we may before long arrive at the power of foretelling the general character of seasons, in regard to their being wet or dry, hot or cold, stormy or gentle; but we see no reason to believe that any amount of study of the past will ever enable us to predict in detail for any length of time in advance, though it may and must lead us to a better capability of rightly interpreting the atmospheric changes going on, of detecting them at their earliest beginning, of judging their probable effects, and thus of extending the period for which "storm warnings" may be made available. With increased experience new power will be gained, new methods will be learned and proved. Even now, the spectroscopic observations by Commander Maclear, to which he called our attention in these columns only a few weeks ago, seem to point hopefully towards a new path in meteorological research; for it is not only in the widely different climate of the Bay of Biscay, the Red Sea, and the Indian Ocean, that he observes the differences in the spectrum which he has spoken of in the article just referred to; he informs us that his later observations lead him to believe that the changes in the atmospheric humidity distinctly correspond to changes in the solar spectrum; that, for instance, an increasing humidity manifests itself by a shortening in of the blue, and by a well marked development of aqueous bands in the red and yellow. Whether further examination will confirm this belief or not it is at present impossible to say, but the spectroscope has done so much towards teaching us the constitution of other atmospheres, that we may fairly entertain a hope that the time has come for it to teach us something about the distant and outlying parts of our own. J. K. L.

Index of Spectra. By W. M. Watts, D. Sc. (London: Henry Gillman.)

ALL workers with the spectroscope must have felt the great inconvenience arising from the employment of numberless different scales in the mapping of spectra. It is to be hoped that at some future time there will be more uniformity, and that authors, when publishing original memoirs, will reduce their measurements to a definite and recognised system. It is clear that such a method must be perfectly independent of the spectroscope and its concomitant parts; the position of each line can therefore only be expressed by its colour, or, in other words, by the length of the wave of light which produces this colour. Dispersion spectra, obtained by the use of prisms of different materials, vary greatly in the relative breadth of the respective colours; thus in the spectrum from crown-glass the red end is larger and the blue end shorter than in the spectra obtained from flint-glass, carbonic disulphide, and by diffraction. It is therefore necessary in spectroscopic researches to record the positions of numerous well-known lines as observed in the instrument that is used. In a diffraction spectrum, however, the position of the lines is dependent solely on their colour, and is precisely the same by whatever method the spectrum is obtained. For the results of different observers to be accurately comparable, the readings obtained by dispersion must either be expressed in wave-lengths, or the spectra must be obtained by diffraction. The wave-lengths of the Fraunhofer lines of the sun have been accurately determined by several observers. The author has adopted as the basis of his work the measurements made by Angström, as these appear to exceed in accuracy all similar measurements at our disposal. When the wave-lengths of a number of lines are known, it is easy to calculate the wave-lengths of the lines of any new spectrum, either by the interpolation formula given by W. Gibbs *Phil. Mag.* [4] xl. 157) or by the method of graphical interpolation, both of which methods are explained in the volume before us; all that is required is to have the wave-lengths of two known lines, between which the line to be measured falls. By the aid of Angström's measurements the author has reduced the measurements of the bright lines of all the elements whose spectra have been carefully investigated, and also of air lines as mapped by Thaler, Huggins, and Plucker. These tables will therefore assist materially in the work of reduction, by serving as landmarks from which to calculate the wave-lengths of new lines. The attention that the author has bestowed on this work is the best guarantee of the accuracy of the numbers given. In the lithographic plates at the end of the tables, a drawing of the spectrum of each element is given on the plan proposed by Bunsen, in which the intensity of a bright line is indicated by the height of the line representing it; a chromo-lithograph is given of the double spectra of nitrogen, sulphur, and carbon, and another plate, showing two spectra obtained by Wülner from aluminium, and three from hydrogen at different powers. Dr. Watts is deserving of the best thanks of all those interested in spectroscopic work, for it is to be hoped that his "Index of Spectra" may contribute to the adoption of a uniform scale of measurement, and thus facilitate the advance of the science. A. P.

LETTERS TO THE EDITOR

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

The Adamites

PHILOLOGISTS will notice with regret a paper bearing the above title in the late number of the *Journal of the Anthropological Institute.* The author appears to have taken up, without proper study, that difficult and dangerous line of argument, the comparison of historical names, and has naturally fallen into the network of delusive fancy which in past generations entangled Jacob Bryant and Godfrey Higgins. Modern philology has abundantly proved that slight, loose, and occasional correspondences in proper names are deceptive as evidence, even among languages of the same family, much more among languages of different families. It is a fair sample of the present paper, that it argues an affinity between the peoples of the Old and New Worlds on the basis of a connection between various names of the Deity, among which are the Russian *Bog*, the Mantchoo *Ab-ka*, and the Hottentot *Teqoa*. The special purpose is to prove that nations are shown by their names to trace descent from an ancestor called *Ad*—"*Adam*, or Father *Ad*." Thus "the great Hamitic race of *Akkad*" is interpreted by the aid of Welsh *ach*—root, lineage," so as to mean "sons or lineage of *Ad*;" and the name of *Ta-ata*, the Polynesian First Man, is "that of the mythical ancestor of the Adamites, reversed, however, and with the addition of *ata* (*aka*), spirit"! It is obvious, though unaccountably overlooked in the paper, that two of the clearest cases of the theory may be found near home. The descent of two nations from Father Ad is perfectly recorded by ourselves, when we call the representative of one a *Paddy*, clearly *Ap-Ad* (from *Ap*, "used in the sense of son"), while the other's Adamite ancestor is commemorated by calling his descendant a *Ta-ffy*.

It is not necessary to give the name of the author of this unlucky paper. Everybody is liable to slips, great or small; and a man may have done work worth doing in one line, but turning suddenly to another, may come to grief utterly. But the Council of the Anthropological Institute should have consulted their own interest and that of their contributor by declining to print the present essay. It is the duty of a learned society to examine even a hasty and ill-considered idea brought forward by one of its members, but not to put it on public record against themselves and him. M. A. I.

The Segmentation of Annulosa

IN the extract from his Address to the Entomological Society, given in NATURE, February 29, Mr. Wallace remarks that Mr. Spencer's views have not been so much as once alluded to in the discussion of the Origin of Insects. The general question of the Annulosa obviously includes that of Insects, and I therefore desire to correct this statement, and to refer your readers to a paper by me on Chœtogaster and Æolosoma, published in the "Linnean Transactions," vol. xxvi. (read Dec. 1867), in which I have more than alluded to Mr. Spencer's views, and have offered some suggestions on the morphology of the head, and as to the unisegmental Annulose ancestor. Mr. Wallace quotes from this paper in reference to Chœtogaster, though from the context it would appear that he is quoting from Professor Owen.

Since the researches which have rendered Mr. Wallace's name one of the first among living zoologists have not led him into practical anatomical and embryological studies, I may venture to add one or two strictures upon his statements relating to such matters. In the first place, those who are engaged in the study of insect embryology are not ignorant of Mr. Spencer's or similar views; the wide-spread study of his works in England and America, and of Haeckel's general morphology in Germany, is sufficient guarantee of this. But even if it were as Mr. Wallace supposes, he has not, in the extract given in NATURE, shown at all how Mr. Spencer's views on aggregation are to influence the study of the embryology of insects. Of course, the general theory of somites has immense importance in all studies relating to the Annulosa, but in what way the particular form of it, due to Mr. Spencer, can influence conclusions drawn from the observation of the manner in which insects develop from the egg, Mr. Wallace does not explain. Whether, admitting or denying the truth of Mr. Spencer's or Prof. Haeckel's views, it would be equally conceivable, did the observed facts point in either direction—that the ancestry of insects is to be traced to a simple nauplius-form or to a multi-segmental Annelid-like progenitor, the question of segmentation is not finally settled, though it is largely elucidated by the doctrine of Mr. Spencer. It is no doubt an instructive point of view to take—that segmentation is an arrested production of zooids, but it is equally true that the production of zooids is an exaggerated segmentation. We have no grounds for assuming the one more than the other as the essential process; they are both phases of the same process. The fact appears to be that in certain masses of organised matter, on their reaching a certain limit of growth, "polarities," which were hitherto held in one system, break up into two and so on. The simplest case of this is cell-division, but whether the systems separate entirely, as in simple fission, or remain associated, as in the cleavage of the egg and in the segmentation of the Annulosa, depends on another factor, a cohesive or integrating force proper to the growing mass.

In the present state of knowledge upon the subject, the assumption adopted and held of so much importance by Mr. Wallace—that the Vertebrata do not exhibit a segmentation of the same kind as that of the Annulosa, is by no means justified. Though much of their jointed iterative structure may probably be due to that kind of adaptation which Mr. Spencer so justly distinguishes as "superinduced segmentation," yet that there is a fundamental bud-segmentation, or segmentation of growth identical with that of Annulosa, is in the very highest degree probable. And even as to the Chiton, which Mr. Wallace quotes from Mr. Spencer as quite certainly an example of superinduced segmentation, I think that had he examined the grounds for making such a statement, he would have hesitated. The larva of Chiton is identical with that of an Annelid, and its segmentation makes its appearance in the same way. Why should there not be segmented molluscs? It is necessary most constantly to bear in mind, when considering this matter of segmentation, the possibility of the partial or complete obliteration of segmental characters due to tertiary aggregation, and their modification in most various ways in the evolution either of an individual or of a group.

Further, as to Mr. Wallace's expressions with regard to the segmentation of insects. From what was said above as to the relation of segmentation and zooid production, it follows that the conception of segmentation is erroneous which leads to ascribing to insects peculiar physiological or psychical properties on account of their being composed of "a number of individualities fused into one." This expression should not be allowed to lead to wider conclusions than those it formulates. As a matter of fact, insects are not a number of individualities fused into one, but rather one individuality partially (and as a reminiscence rather than actually) broken up into many, this partial breaking up being due to the mechanical properties of its tissues at a certain period of development.

If, by the "spiracles" of Annelids, Mr. Wallace means the segmental organs, it should be clearly stated that the identity of these with the tracheæ of insects has not yet been in any way proved. The comparison of the mode of development of these two sets of organs is just one of the points upon which embryologists are now at work.

Lastly, the researches of the last fifteen years do not, I venture to submit, lead to the conclusion adopted by Mr. Wallace, that the parthenogenesis of the higher Annulosa is analogous to or identical with gemmation as opposed to sexual reproduction or digenesis, but to the conclusion which is exactly opposed to this, namely, that it is identical with digenesis in all particulars but the absence of the male element.

Naples E. RAY LANKESTER

Adaptive Coloration, Phosphorescence, &c.

NO one who has watched a very young hare stealing from a green covert to brown soil, and observed its cunning movements there when alarmed, can for a moment doubt the value of colour as a protection to the higher animals.

The remarks by Mr. E. S. Morse in NATURE of last week bring to my recollection a good instance (among invertebrates) which occurs on the reddish granite of Cobo Bay, Guernsey. There *Trochus lineatus* especially abounds on the bare parts of the rocks between tide-marks; and every observer must be at once struck by the remarkable fitness of the mollusk for its peculiar site.

Mr. Darwin in truth says,* "It would not, for instance, occur to any one that the perfect transparency of the Medusæ or jelly-fishes, was of the highest service to them as a protection; but when we are reminded by Häckel that not only the Medusæ, but many floating mollusca, crustaceans, and even small oceanic fishes, partake of this same glass-like structure, we can hardly doubt that they thus escape the notice of pelagic birds and other enemies;" but he makes no mention of the gorgeous colouring of some of these swimming jellies, nor is there any allusion to their remarkable property of phosphorescence. The transparency of the British Salpæ does not prevent their being attacked by sea-birds, which hover in multitudes over them, masses of Medusæ and other Hydrozoa, and a few minute fishes.

If instead of promulgating the visionary idea that the abysses of the ocean depended for their light on phosphorescent animals, the dredgers† in the *Porcupine* had applied the notion that the various luminous marine animals used their light to attract each other, so that the most luminous might have a better chance of continuing the race, they would have been able to say more in its favour, without, at least, running counter to established facts.

Murthly, March 26 W. C. McINTOSH

The Aurora of February 4‡

AN aurora of a very unusual splendour for the latitude was seen here on Sunday evening February 4, 1872. The sky, extending in azimuth over 197° from N.E. to nearly W.S.W., was generally illuminated. The brilliance of the glow varied considerably in different directions from time to time during the night. On the south horizon there was a bright bluish segment of light, whose position in azimuth and brilliance varied slightly from time to time. The streamers were well seen, and their convergence towards the point to which the south pole of a magnet is directed could be most distinctly traced. The streamers extended at about nine o'clock to the constellation Orion, and Sirius was well within the auroral glow. With a spectroscope I saw one bright line in the spectrum of the auroral light, but the spectrum was too faint to allow of any successful attempt to determine the refrangibility of the light. Unfortunately our magnetical equipment is such that I can give no information respecting the extent of the magnetical disturbance at the time. The aurora was seen as far north as Bloemfontein, latitude 29° 8′ south. A faint aurora was seen here in October 1870, but no such aurora as that of February 4, 1872, appears to have been visible for at least fifty years. The aurora was well seen over a large portion of the colony, and considerably frightened the natives.

E. J. STONE

Royal Observatory, Cape of Good Hope, Feb. 19

* "Descent of Man," vol. i., p. 322.
† Not, however, Mr. Jeffreys
‡ Communicated by the Astronomer Royal.

SEEING your account of the aurora of February 4 in NATURE of the 22nd, reminds me that on the evening of the 4th I was riding from Cambridge to Coldwell, in Ohio, and between six and seven o'clock saw a most brilliant display of auroral light in the southern quarter of the sky. Brilliant streamers shot up past the zenith, while the whole southern portion of the sky was brightly illuminated with a corruscating rose-coloured light.

Marietta, Ohio., March 15 A. J. WARNER

Morse on Terebratulina

I HAVE just read the very kind notice of my paper * in the pages of your journal from the pen of Mr. E. R. Lankester. I hasten, however, to remove one impression conveyed in the following sentence, respecting the opinions I hold as to the Annelidan affinities of the Brachiopods:—

"We are not sure whether Mr. Morse adheres to this startling proposition."

I trust the long delay in publishing the results of my studies on this interesting class will lead no one to suppose that I have yet seen reason to modify the position I took two years ago regarding their position in the animal kingdom. On the contrary, continued investigation has brought out many new points of interest, and now I hope, ere my paper is published, to present the embryology of some one of them.

I had studied our native Terebratulina, its structure, as well as its early stages, and through the kindness of Prof. Verrill, had studied *Discina lævis* (upon which I hope soon to publish).

Mr. Lankester, as the author of many valuable memoirs requiring much skill and patient labour, will fully appreciate the time and care necessary in work of this kind.

As to my being unduly impressed at the sight of living Lingulæ, I may say, in justice to myself, and my friends will testify to it, my opinions were fully formed before I ever saw Lingula at all. With the caution that is requisite for every one, if he does not wish to supplement his paper with a correction of errors, a way of doing things altogether too frequent in this country, I deemed it important to study living Lingula before publishing. It was impossible for me to go half-way round the world for it. And as three specimens of another species have been found on the coast of North Carolina, I determined to go there. A trip of nearly a thousand miles brought me to its waste of drifting sands.

Thoroughly convinced as to the correctness of my views, and these views of sufficient strength to convince my co-labourers, Mr. Lankester will understand my enthusiasm when, after a week's fruitless search under a blazing sun, and an almost hopeless task, I found Lingula, not as we have always supposed attached by its peduncle, but living in the sand, precisely like many tubicolous worms, building a true sand tube, and when liberated from it crawling and burrowing by means of its setæ, and with all these welcome characters it should greet me with red blood. Not that I lay great stress on any one of these characters, but having made my deductions from the most common form, Terebratulina, one can readily understand the bearing of such unexpected characters in this little Lingula.

Mr. Lankester will admit that the Vermian lumber-room has some orderly compartments; into one of those I place the Brachiopods far away from all Molluscan odours.

The distinguished naturalist, Prof. Steenstrup, informs me that he has long taught his classes at the University of Copenhagen that the Brachiopods were true Annelids, and that my views are thoroughly endorsed by him. To him, therefore, and not to me as had been supposed, belongs the priority of this discovery.

I only ask a little patience till my complete paper is published on the Brachiopods as a division of Annelida, in which I shall give appropriate figures, and my reasons in full for the position I have taken. EDWARD S. MORSE

Salem, Mass., U.S.A., March 14

On the Colour of a Hydrogen Flame

WHEN hydrogen and oxygen are burned together, it is well known that the flame produced is almost non-luminous; it always, however, exhibits an unmistakeably blue tinge.

The small illuminative power is generally referred to the "absence of solid particles." This view, it appears to me, draws a too rigid line of demarcation between the atoms of carbon in an ordinary gas-coal flame and the atoms of hydrogen in that of the oxyhydrogen. The cause of the phenomenon does not depend so much on the *solidity* as it does on the time of oscillation of the particles which constitute the flame. Water particles in all their states of aggregation preserve the same time of oscillation—extra red; hence a hydrogen flame should be perfectly invisible whatever may be the "solidity" or density of its particles.

But the flame is not invisible, and, what is still more remarkable, the colour which it does exhibit is found to belong to the most refrangible end of the spectrum. To explain this strange phenomenon, it appears to me that it is necessary to invoke a state in the ether particles similar to that which Helmholtz has shown to exist in air; and which is this:—A tuning-fork "vigorously struck against a pad emits the *octave* of its fundamental note." Now, the first overtone of a tuning fork is produced by vibrations about $6\frac{1}{4}$ times as rapid as the fundamental; the octave, therefore, is not an overtone of the fork—it is produced solely in consequence of the fact that the initial disturbance is great in proportion to the distance of the air particles from one another, secondary waves being produced whose periods are twice as rapid as those of the fundamental.

The amplitude of the particles in a hydrogen flame is known to be very great, and hence it seems probable that an effect may result from the disturbance thus created in the ether, analogous to that in the case of air, *i.e.*, associated with the fundamental vibrations of the hydrogen flame we have their *octave*, which would obviously be within the visual range, and correspond very closely, if not *exactly*, with the colour actually observed.

Should this surmise prove correct we have plainly an easy means by which we can determine the wave-length of those extra-red rays which are absorbed by water.

A. G. MEEZE

Hartley Institution, Southampton, March 26

P.S.—May not the great *actinic* power of the electric light be due in a great measure to the secondary waves produced by the magnitude of the disturbing force?

* "Early Stages of Terebratulina."

VESTIGES OF THE GLACIAL PERIOD IN NORTH-EASTERN ANATOLIA

ATTENTION was drawn to this subject in a lecture given on March 25 at the Royal Geographical Society by the Eastern traveller Mr. W. Gifford Palgrave, at present British Consul for the northern coast of Asia Minor. The facts which he mentioned had been principally observed by him during a tour on duty to the interior about two years ago; and the line of route lay from the town of Trebizond on the sea coast to that of Erzinghian on the Upper Euphrates.

The phenomena themselves were divided into two classes: the one referable to the highlands which he had then traversed, the other to their marginal region.

These highlands are situated on or near the 40th parallel of latitude, and extend between the 37th and 44th of longitude, east and west; their average breadth being about fifty miles, and their elevation varying from 3,000 to 9,000 feet above the sea. They constitute the great watershed of Eastern Anatolia; the rivers to the south of them flowing into the Persian Gulf, and those to the north into the Black Sea. To the west is the basin of the Halys, to the east that of the Caspian.

The road leading across this plateau towards Erzinghian, mounts up to it by a defile named "Ketcheh-Dereh," or "Goats' Valley." Here, at a height of about 5,400 feet above the sea, Mr. Palgrave came on the lower extremity of a large moraine, piled up to a height of more than twenty feet, and broad in proportion. Following it for a distance of nearly half a mile, he found that when it had reached between 400 and 500 feet higher up the slope, it forked into two lesser branches, continued each a good way further into the rising undulations of the table-land.

The plateau itself bore every mark of having lain under a thick ice-coating; its eminences and irregularities all bearing the "moutonnée" character impressed by glacial action; while it was also frequently strewn with detached boulders and pieces of rock, scratched and scored with the unmistakeable lines that glaciers alone produce. These phenomena he observed to be repeated, or rather continued, throughout the highland, which he crossed three times at intervals, including above 100 miles of its length.

About the midmost of the plateau stands a solitary, dome-like eminence, nearly 8,000 feet above the sea level, and rounded off in every direction. On the west side of this mountain, now known as "Yelish Dagh," near its base, Mr. Palgrave found a second moraine, consisting of a single stone bank five or six hundred yards in length, stretching down to a valley below: its higher extremity was at about 6,500 ft. And lastly, at the great cleft about fifty miles distant, called the Cherdakh Pass, and leading downwards from the plateau into the Euphrates valley, he observed a third moraine, larger than either of the two former, and extending over a slope of fully 2,000 ft., its base being only about 4,500 ft. above the sea.

From these and similar indications, Mr. Palgrave conjectured that during the glacial period an ice-cap of fifty miles in average breadth, and many hundred in length, must have covered this table-land from a height of 6,000 ft.. or rather less, upwards; while some of the more advanced glaciers may have reached to a far lower level, seemingly 4,000 ft.

Such were the most remarkable surface-phenomena of the plateau itself. But on its margin, whether north or south, and connected with it, were other indications of an analogous character. These consisted in the traces afforded by broad and deep ravines and neighbouring river beds, much too wide for the streams that flow through them; all affording evidence of a past epoch when the water supply was on a far more copious scale than it is now. Thus the valley of the Euphrates itself, which takes its rise in this very plateau, is, in its evenly-scooped extent of three and even four miles across, out of all proportion with the comparatively little and feeble stream that now meanders along it; and the same must be said of most of the aqueous modifications imprinted in the lower mountain ranges, and in the plains at their feet.

But of all the phenomena of this kind none is more remarkable than that inspected by Mr. Palgrave near the sea-end of the great valley by which the river, once Pyxartes, now "Deyermend-Dereh," or "Mill Stream" enters the Euxine, close by Trebizond. This river, whose waters are derived from the central table land, is now so shallow as to be readily fordable at almost every season of the year, and brings down with it just enough pebble and soil to form a little bar at its mouth. Half a mile, however, from the present beach the river valley, here about a third of a mile in width, is in its greater part crossed by a huge bar of rolled stones, at least forty feet in eight, and eighty or a hundred yards in thickness at its base, evidently formed here by the joint action of river and sea. The stones, many of which are of great size, belong to Jurassic or Plutonic formations, such as compose the plateau inland, whereas the coast-rock is entirely volcanic. But the flood of water requisite to bring them from such a distance is now wholly wanting. Nor can its diminution be ascribed to the extirpation of forest wood, for the mountain chain is still as densely clothed with trees as it could ever have been in remote times; nor yet to an alteration in the course and dip of the valleys that unite to send their supplies hither, for there is no trace of any great geological change hereabouts within the epoch to which the bar itself is referable. One only cause there could have been capable of furnishing so impetuous a stream, namely, the periodical melting of great masses of ice and snow on the mountains behind, now unusually bare of snow from June till November, and absolutely denuded of anything approaching to a glacier. When these icy reservoirs ceased the abundance of the river ceased also, leaving the bar alone as a monument of its former strength.

T. P.

THE INHABITANTS OF THE MAMMOTH CAVE OF KENTUCKY

Crustaceans and Insects

THE following account of the inhabitants of the Mammoth Cave of Kentucky is abridged from the *American Naturalist*. To the courtesy of the editors of that journal we are further indebted for the accompanying illustrations:—

After the adjournment of the meeting of the American Association for the Advancement of Science, held at Indianapolis in August last, a large number of the members availed themselves of the generous invitation of the Louisville and Nashville Railroad Company, to visit this world-renowned cave, and examine its peculiar formation and singular fauna.

The cave is in a hill of the subcarboniferous limestone formation in Edmondson County, a little to the west and south of the centre of Kentucky. Green river, which rises to the eastward in about the centre of the State, flows westward, passing in close proximity to the cave, and receiving its waters, thence flows north-westerly to the Ohio. The limestone formation in which the cave exists is a most interesting and important geological formation, corresponding to the mountain limestone of the European geologists, and of considerable geological importance in the determination of the western coalfields.

We quote the following account of this formation from Major S. S. Lyon's report in the fourth volume of the "Kentucky Geological Survey," pp. 509, 510:—

"The sinks and basins at the head of Sinking Creek exhibit in a striking manner the eroding effects of rains and frost—some of the sinks, which are from 40 ft. to 190 ft. deep, covering an area of from 5 to 2,000 acres. The rim of sandstone surrounding these depressions is, generally, nearly level; the out-cropping rocks within are also nearly horizontal. Near the centre there is an opening of from 3 ft. to 15 ft. in diameter; into this opening the water which has fallen within the margin of the basin has been drained since the day when the rocks exposed within were raised above the drainage of the country, and thus, by the slow process of washing and weathering, the rocks which once filled these cavities have been worn and carried down into the subterranean drainage of the country. All this has evidently come to pass in the most quiet and regular manner. The size of the central opening is too small to admit extraordinary floods; nor is it possible, with the level margin around, to suppose that these cavities were worn by eddies in a current that swept the whole cavernous member of the subcarboniferous limestone of western Kentucky; but the opinion is probable that the upheaving force which raised these beds to their present level at the same time ruptured and cracked the beds in certain lines: that afterwards the rains were swallowed into openings on these fractures, producing, by denudation, the basins of the sinkhole country, and further enlarging the original fractures by flowing through them, and thus forming a vast system of caverns, which surrounds the western coalfield. The Mammoth Cave is at present the best known, and therefore the most remarkable."

So much has been written on the cave and its wonders, that to give a description of its interior would be superfluous in this connection, even could we do so without unintentionally giving too exaggerated statements, which seems to be the natural result of a day underground, at least so far as this cave is concerned, for, after reading any account of the cave, one is disappointed at finding the reality so unlike the picture.

We are indebted to Prof. Alexander Winchell, of the University of Michigan, for the following abstract of his views concerning the formation of the cave:—

"The country of the Mammoth Cave was probably dry land at the close of the coal period, and has remained such, with certain exceptions, through the Mesozoic and Cænozoic ages, and to the present. In Mesozoic times, fissures existed in the formation, and surface waters found

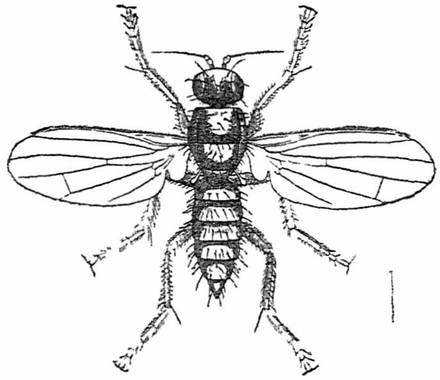

Fig. 1.—Anthomyia.

their way through them, dissolving the limestone and continually enlarging the spaces. A cave of considerable dimensions probably existed during the prevalence of the

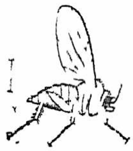

Fig. 2.—Phora.

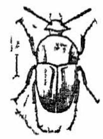

Fig. 4. Adelops hirtus

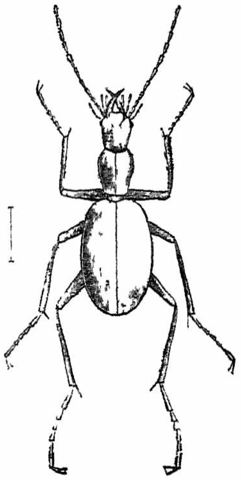

Fig. 3.—Anophthalmus Tellkampfii.

continental glaciers over the northern hemisphere. On the dissolution of the glaciers, the flood of water which swept over the entire country, transporting the materials

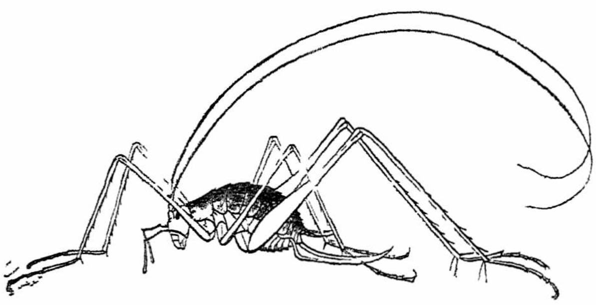

Fig. 5—Hadenœcus subterraneus.

which constituted the modified drift, swept through the passages of the cave, enlarging them, and leaving deposited in the cave some of the same quartzose pebbles which characterise the surface deposits from Lake Superior to the Gulf of Mexico. Since the subsidence of the waters of the Champlain epoch, the cave has probably undergone comparatively few changes. The well, 198 ft. deep, at the farther end of the cave, shows where a considerable

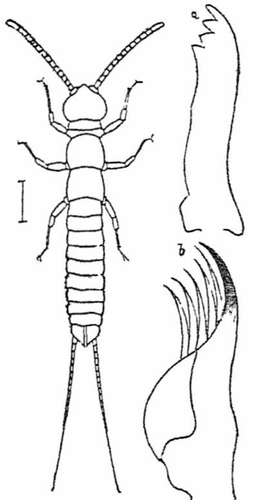

Fig. 6.—Campodea.

volume of the excavatory waters found exit. The Mammoth Dome indicates probably both a place of exit and a place of entrance from above. So of the vertical passages in various other portions of the cave."

We believe that the views of Prof. Winchell are in har-

Fig. 7.—Anthrobia monmouthia.

mony with those of the other eminent geologists of the party; and when it is considered that the geologists of this excursion stand in the front rank of the most eminent scientific men of the world, their views upon this interesting subject are well worthy of attention.

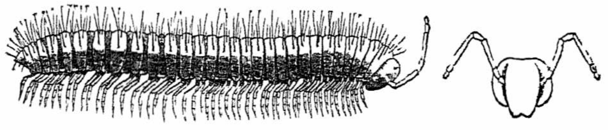

Fig. 9.—Spirostrephon Copei.

With these general remarks on the cave, we give a brief account of its interesting fauna, comprising representatives of the insects and crustaceans. No molluscs or radiates have as yet been discovered; but the lower forms of life have been detected by Tellkampf, who collected several species belonging to the genera *Monas*, *Chilomonas*, and (?) *Chilodon*.

Representatives of all the grand divisions of the insects and crustaceans have been found in this cave, and if no worms have yet been detected one or more species would undoubtedly reward a thorough search.

We will enumerate what have been found, beginning with the higher forms. No Hymenoptera (bees, wasps, and ants) or Lepidoptera (moths) are yet recorded as being peculiar to caves. The Diptera (flies) are represented by two species, one of Anthomyia (Fig. 1), or a closely allied genus, and the second belonging to the singular and interesting genus Phora (Fig. 2.) The species of Anthomyia usually frequent flowers; the larvæ live in decaying vegetable matter, or, like the onion fly, attack healthy roots. It would be presumptuous in the writer to attempt to describe these forms without collections of species from the neighbourhood of the cave, for though like all the rest of the insects they were found three or four miles from the mouth, yet they may be found to occur outside of its limits, as the eyes and the colours of the body are as bright as in other species.

Among the beetles, two species were found by Mr. Cooke. The *Anopthalmus Tellkampfii* of Erichson, a Carabid (Fig. 3), and *Adelops hirtus* Tellkampf (Fig. 4), allied to Catops, one of the Silphidæ or burying beetle family. The Anopthalmus is of a pale reddish horn colour, and is totally blind;* in the Adelops, which is greyish brown, there are two pale spots, which may be rudimentary eyes, as Tellkampf and Erichson suggest. No Hemiptera (bugs) have yet been found either in the caves of this country or Europe. Two wingless grasshoppers (sometimes called crickets) like the common species found under stones (*Ceuthophilus maculata* Harris), have been found in our caves; one is the *Hadenœcus subterraneus* (Fig. 5 nat. size) described by Mr. Scudder, and very abundant in Mammoth Cave. The other species is *H. stygia* Scudder, from Hickman's cave, near Hickman's landing, upon the Kentucky river. It is closely allied to the Mammoth Cave species. According to Mr. Scudder the specimens of *H. stygia* were found by Mr. A. Hyatt "in the remotest corner of Hickman's Cave, in a sort of a hollow in the rock, not particularly moist, but having only a sort of cave dampness. They were found a few hundred feet from the sunlight, living exclusively upon the walls." Even the remotest part of that

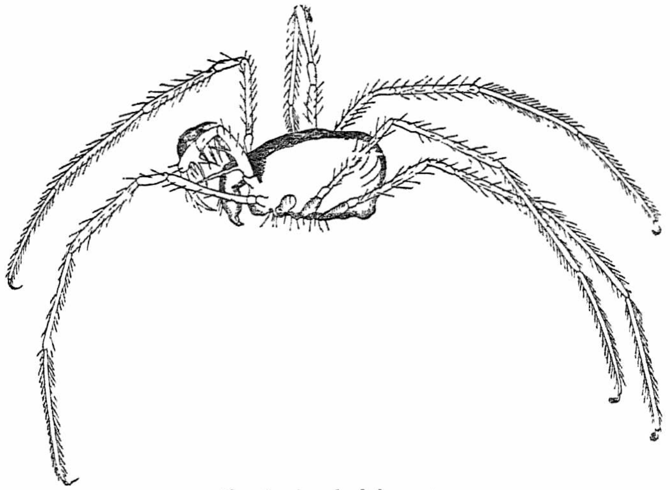

FIG. 8 —Acanthocheir armata.

cave is not so gloomy but that some sunlight penetrates it.

The other species is found both in Mammoth Cave, and in the adjoining White's Cave. It is found throughout the cave, and most commonly (to quote Mr. Scudder) "about 'Martha's Vineyard" and in the neighbourhood of 'Richardson's Spring' where they were discovered jumping about with the greatest alacrity upon the walls, where only they are found, and even when disturbed, clinging to the ceiling, upon which they walked easily; they would leap away from approaching footsteps, but stop at a cessation of the noise, turning about and swaying their long antennæ in a most ludicrous manner, in the direction whence the disturbance had proceeded; the least noise would increase their tremulousness, while they were unconcerned at distant motions, unaccompanied by sound, even though producing a sensible current of air; neither did the light of the lamp appear to disturb them; their eyes, and those of the succeeding species (*H. stygia*), are perfectly formed throughout, and they could apparently see with ease, for they jump away from the slowly approaching hand, so as to necessitate rapidity of motion in seizing them."

The Thysanurous Neuroptera are represented by a species of Machilis, allied to our common *Machilis variabilis* Say, common in Kentucky and the middle and southern States. So far as Tellkampf's figure indicates, it is the same species apparently, as I have received numerous specimens of this widely distributed form from Knoxville, Tennessee, collected by Dr. Josiah Curtis. It was regarded as a crustacean by Tellkampf, and described under the name of *Triura cavernicola*.† He mistook the labial and maxillary palpi for feet, and regarded the nine pairs of abdominal spines as feet. The allied species, *M. variabilis* Say, is figured in vol. v. pl. 1, figs. 8, 9.

* In Erhardt's cave, Montgomery Co., Virginia, Prof. Cope found "four or five specimens of a new Anopthalmus, the *A. pusio* of Horn, at a distance of not more than three hundred feet from its mouth. The species is small and all were found together under a stone. Their movements were slow, in considerable contrast to the activity of ordinary Carabidæ." Proc. Amer. Phil. Soc. 1869, p. 178.

† Prof. Agassiz, in his brief notice of the Mammoth Cave animals, does not criticise Tellkampf's reference of this animal to the crustacea; and so eminent an authority upon the articulates as Schiödte remarks, while "Dr. Tellkampf's account affords us no means of forming any conclusion as to its proximate relations," that, however, it "appears to belong to the order of Amphipoda, and to have a most remarkable structure." Tellkampf's figure of Machilis is entirely wrong in representing the labial and maxillary palpi as ending in claws, thus giving the creature a crustacean aspect, and, indeed, he describes them as true feet!

An interesting species of Campodea, of which the accompanying cut (Fig. 6) is a tolerable likeness, though designed to illustrate another species (*S. staphylinus* Westw.) was discovered by Mr. Cooke. Both the European and our common species live under stones in damp places, and the occurrence of this form in the water is quite remarkable. The other species are blind, and I could detect no eyes in the Mammoth Cave specimen.

A small spider was captured by Mr. Cooke, but afterwards lost; it was brown in colour, and possibly distinct from the *Anthrobia monmouthia* Tellkf. (Fig. 7), which is an eyeless form, white and very small, being but half a line in length. The family of Harvest men is represented by a small white form, described by Tellkampf under the name of *Phalongodes armata* (Fig. 8), but now called *Acanthocheir armata* Lucas. The body alone is but half a line long, the legs measuring two lines. It should be borne in mind that many of the spiders, as well as the Thysanura, live in holes and dark places, so that we could naturally find them in caves. So, also, with the Myriopods, of which a most remarkable form (Fig. 9 front of head) was found by Mr. Cooke three or four miles from the mouth of the cave. It is the only truly hairy species known, an approach to it being found in *Pseudotremia Vudii* Cope. It is blind, the other species of this group which Prof. Cope found living in caves having eyes. The long hairs arranged along the back seem to suggest that they are tactile organs, and of more use to the thousand legs in making its way about the nooks and crannies of a perpetually dark cave than eyes would be. It was found by Mr. Cooke under a stone.

Prof. Cope has contributed to the "Proceedings of the American Philosophical Society" (1869, p. 171) an interesting account of the cave mammals, articulates, and shells of the middle states. He says that "myriopods are the only articulates which can be readily found in the remote regions of the caves (of West Virginia) and they are not very common in a living state." The *Pseudotremia cavernarum* which he describes, "inhabits the deepest recesses of the numerous caves which abound in Southern Virginia, as far as human steps can penetrate. I have not seen it near their mouths, though its eyes are not undeveloped, nor smaller than those of many living in the forest. Judging from its remains, which one finds under stones, it is an abundant species, though rarely seen by the dim light of a candle even after considerable search. Five specimens only were procured from about a dozen caves." The second species, *P. Vudii* Cope, was found in Montgomery Co., and he thinks it was not found in a cave. Prof. Hyatt informs me that he saw near the "Bottomless Pit" in Mammoth Cave, a brownish centipede-like myriopod, over an inch in length, which moved off in a rapid zigzag motion. Unfortunately, he did not capture it.

A. S. PACKARD, JUN.

(*To be continued*)

NOTES

WE have received information of a most munificent act on the part of that veteran in Geological Science, Sir William E. Logan, in supplementing, by the handsome gift of 18,000 dols., the sum of 2,000 dols. given by him and his brother, Mr. Hart Logan, last year towards the endowment of the Chair of Geology in M'Gill University, Montreal. The "Logan Chair of Geology" will be at once a commemoration of Sir William's name in connection with the higher education of our colonists, and a means of perpetuating the teaching of the Science for which he has done so much, as well as of securing the training of a succession of young men who may worthily follow up his investigations in the wide field of Canadian Geology. Principal Dawson, who at present occupies the Chair of Geology, will be the first "Logan Professor," and it is intended that the endowment shall, as soon as possible, be made the means of relieving him from the teaching of some other portions of natural science, in order that he may more fully devote his time to Geology and Palæontology.

PROF. HUXLEY is now on his way home to England, having been last heard of from Naples. His health is very greatly restored by his absence from work, and the effects of the Egyptian climate.

DR. M'NAB, Professor of Botany and Geology at the Royal Agricultural College, Cirencester, has been appointed Professor of Botany to the Royal College of Science and Art, Dublin, in the place of Prof. Thiselton Dyer. The appointment is a good one, on which we congratulate the Science and Art Department. The lectureship at the Cirencester College is now vacant.

THE death of the Swiss palæontologist, M. Pictet de la Rive, Professor in the Academy of Geneva, which we noticed last week, took place on the 15th ult. at the age of sixty-two, and was occasioned by fever induced by a severe accident.

DR. GEORGE BURROWS, F.R.S., has been re-elected President of the College of Physicians.

PROF. HUXLEY was defeated by a small majority by Lord Neaves in the election for the Rectorship of St. Andrew's University. Prof. Sylvester was also, we regret to say, unsuccessful in his candidature for the School Board for Marylebone. We understand, however, that there will shortly be another vacancy on the Board, when we trust Science will once more put in its claim.

THE Brighton Aquarium was formally opened to the public on Saturday last.

IT has been decided to give a private view and evening reception in the Picture Galleries of the London International Exhibition of 1872 before the 1st of May, to which distinguished foreigners and holders of season tickets will be invited.

AT Rugby Mr. Wilson and Mr. Seabroke have tried the experiment of giving regular lectures on Astronomy to a class consisting of volunteers from the school and residents in the town. Note-books were shown up and corrected, and an examination held at the end. About seventy attended, twenty being members of the school; thirty showed up note-books, and eighteen presented themselves for examination. Advocates of women's education will be pleased to learn that the two best note-books were written by girls, and that in the examination, which was a stiff one (we have seen the paper), girls held the second, third, and fifth places. The proceeds are for buying books for the Temple Observatory.

AN organisation, entitled the Bloomington Scientific Association, was instituted at Bloomington, Illinois, in 1871, having for its object the diffusion and popularising of science in that State. The officers are Prof. B. S. Perry, Mr. R. H. Holder, Dr. Vasey, and Mr. J. A. Jackman. The society has already a large number of members, and meets frequently.

THE great depression of temperature during November and the early part of December, was followed by an extraordinarily long period of more than three months' remarkably mild weather. For the ninety-seven days from December 13 to March 18, Mr. Glaisher's Greenwich tables, recorded weekly in the *Gardener's Chronicle*, show that the temperature was above the average on eighty-nine, and below the average on only eight days, the mean excess for the whole period being 5°·1. During the whole of this period the thermometer fell below the freezing point on four nights only, viz., January 15 and 16, and March 10 and 11; the lowest temperature recorded being 28°·3 Fahr. on the first and last of these dates.

February, it will be seen, was entirely free from frost, the minimum for that month being 32°·4, on the 28th. The warmest period was from March 1 to 8, when the maximum temperature ranged each day from 57°·1 to 60°·8. It will be interesting to know whether so long a period of exceptionally high temperature, including fifty-three consecutive days entirely free from frost, has ever been recorded before in the depth of winter. On March 19 the average temperature of the day fell below the mean, and continued so for nine days, till the 27th. The minimum temperature for March was on the 21st, 26°·2 Fahr., being the lowest recorded since Dec. 9. There were nine frosty nights in March, against the two in the whole of the two preceding months. For the week ending March 26 the mean temperature was 34°, or 16° lower than the mean for the week ending March 7.

A CORRESPONDENT of *The Blue* strongly urges the desirability of the formation of a Natural History Society at Christ's Hospital; and the editor of that magazine promises his assistance to the proposal. We heartily wish it success.

THE proposed Act for appropriating the Yellowstone Park for public purposes (to which we recently referred), has passed the Congress of the United States. The following are extracts from the Bill :—"That the tract of land in the territories of Montana and Wyoming (as already described) is hereby reserved and withdrawn from settlement, occupancy, or sale under the laws of the United States, and dedicated and set apart as a public park or pleasuring-ground for the benefit and enjoyment of the people. That said public park shall be under the exclusive control of the Secretary of the Interior, whose duty it shall be, as soon as practicable, to make and publish such rules and regulations as he may deem necessary or proper for the care and management of the same. Such regulations shall provide for the preservation from injury or spoliation of all timber, mineral deposits, natural curiosities, or wonders within said park, and their retention in their natural condition. The Secretary may, in his discretion, grant leases for building purposes for terms not exceeding ten years, of small parcels of ground, at such places in said park as shall require the erection of buildings for the accommodation of visitors; all of the proceeds of said leases, and all other revenues that may be derived from any source connected with said park, to be expended under his direction in the management of the same, and the construction of roads and bridle-paths therein. He shall provide against the wanton destruction of the fish and game found within said park, and against their capture or destruction for the purposes of merchandise or profit." Such a step in the interest of science deserves more than a passing recognition from this side the water.

THE *British Medical Journal* prints the following admirable reply to the extraordinary article which appeared in the *Saturday Review* of the 16th ult., on Dr. Liebreich's lecture on "Turner and Mulready," which we gave last week :—"It is not, of course, always to be expected that *Saturday* Reviewers should have a very profound knowledge of their subjects; but it might be thought advisable that an analysis of an optical argument should not be publicly undertaken by a gentleman who is ignorant of the first rudiments of the subject, and so little acquainted with even the alphabet of its language as the gentleman who discusses, in the last *Saturday Review*, the visual defects of Turner and Mulready. He pronounces a 'verdict of not proven' on Mr. Liebreich's argument; and his fitness for appreciating a discussion of the effects of yellow discoloration of the lens, occurring with advancing old age, on Mulready's perception of colour, may be estimated by the following sentence: 'Let us suppose a person to put on a pair of yellow spectacles. The effect is *assumed* to be, and we think *correctly*, that the *yellow* in a landscape or in a picture, unless extra strong, would be *scarcely recognised;* and that the *blues also*, unless very decisive, would be *neutralised*. The consequence seems to follow, that the painter would throw *ultra force into both yellow and blue:* though against this supposition it must not be forgotten that the spectacle or the crystalline lens, as the case may be, would discolour precisely in *the same degree the tones in nature and the pigments on the palette*.' The italics are ours. There is scarcely a word in this astonishing statement which is not entirely a mistake. It was not assumed, but it is known, that, seen through a yellow glass, the yellows in a landscape are seen relatively more strongly, while the blues are partly neutralised. It was not assumed that the effects of viewing a landscape and a picture through a yellow lens or glass are the same; but, on the contrary, it was stated, as the result of experiment, that they are entirely different. The retina becomes presently so far accustomed to the yellow medium, that the strong lights reflected from blue surfaces in nature overpower the yellowness of the medium, and the blues of a landscape are presently but little neutralised. The reflections from pigments, poor imitations as as they are, at the best, of nature, have not the same power; a large part is neutralised by the yellow glass or lens: and to produce with pigments, on a canvas, blues which satisfy his eye as comparable with those which he sees in nature, the painter—who in old age has the pigment-yellowness of senile change in the lens—employs much deeper blues than he would have done in youth, or than impress youthful eyes as representing the natural tints truthfully. That is why, on Liebreich's theory, Mulready, in painting the same picture in old age which he had painted in middle life, introduced ultramarine into the flesh tints—painted a linen smock of the brilliancy of a glittering silk; and that is the key which he affords to the prevailing excess of purple tints which the official catalogue describes as characterising the latest works of this great artist. The great master himself was, in his later life, dissatisfied for this reason with the colour of his earlier works; he thought them too brown, and used to warn his pupils to paint with stronger blues, especially in the grey shadows.'

IN a letter addressed by von Heuglin to Middendorff, of the St. Petersburg Academy, we find the fullest details of the explorations instituted by that eminent traveller during the past summer in the Nova Zembla seas. In this he remarks that the original plan included a visit to the mouths of the Obi and Yenisei, perhaps even extending to the island of New Siberia. This, however, was found to be impracticable on account of unseasonable weather, as it was not till the 6th of August that they reached the Straits of Matotschkin. Up to that time they had met with no ice; but after passing the straits to the east there was very much drift ice from the sea of Kara so as almost to bar their way. Finding that the northern coast of the island was entirely embargoed by ice, they turned to the south, and in passing visited the Straits of Kostin and the Nechwatowa, then Waigatsch, and finally arrived at the Straits of Jugorsky on the 1st of September. Here the expedition did not make any better progress than in the Straits of Matotschkin, and fearing that they might be shut in by the ice for the winter, they returned to their starting-place. Among the more important results of the voyage were numerous soundings and measurements of deep-sea temperatures, as also various geographical determinations; while large collections of specimens of natural history were brought together. Among these the most interesting was the discovery of two different species of lemming in Nova Zembla, and it was thought possible that in Southern Nova Zembla still a third species might be met with. The same animal was also found in Spitzbergen. Numerous birds were obtained in Nova Zembla and Waigatsch; among them the Mandt's Guillemot. Of fishes, some species of cod, cottus, and salmon were obtained, and about one hundred species of plants.

INDIAN papers give the following additional accounts of the aurora of February 4:—Such a phenomenon has not been observed in the Punjab, or perhaps in India, within the memory of man, and in consequence the remarks made by the natives and others born in the country were rather curious. A curious circumstance took place at Raikote. About 100 Kooka families turned out in the most excited state, and commenced those wild demonstrations from which the name *Kooka* is derived. The men tore off their turbans, unloosed their hair, and began dancing and waving their arms about, and shouting that this was a token that Ram Singh had returned to his home. They were much disappointed to learn that they were mistaken. At Sealkote many thought that the red in the sky was the reflection of the blaze of some hill forest on fire, and one individual at Jhelum suggested that it must be caused by some volcanic eruption in the Himalayas. In another place a commissariat officer was thrown into an agony of terror, thinking it was his haystacks on fire. A correspondent, writing from Madhopore, says:—"On the night of the 4th instant, between 11 and 12 o'clock, there appeared in the sky a clear bright light, like fire, which lasted about fourteen minutes. It was so bright that we were able to see even the minutest objects; owing to its red colour the river appeared as though it were blood. The atmosphere for days has never been clear of clouds, and it seems as if a storm were portending. The lightning injured some natives on the 5th inst."

A CORRESPONDENT suggests that the memory of Dr. Priestley will not be so worthily honoured by a bad statue as by a thoroughly well-appointed School of Science to be called "The Priestley Institution," or whatever other name be thought fitting. Science is much needed to supplement the technical skill employed in the industries of the Black Country, and is not in that district so well provided for as to render the establishment of such a school unneedful. Or if that undertaking be thought too vast, he proposes the endowment at the Newcastle College or elsewhere of a scholarship of Physical Science, to provide young aspirants from the Midland Counties with opportunities of scientific practice and culture. Or if this suggestion do not find favour, possibly the ingenuity of the committee can devise some scheme of a similar sort, so that thus the funds subscribed for this memorial may be used for science.

WE note the proposed formation of a National Swimming Baths Company (Limited), to provide good and cheap swimming baths in the Thames.

ACCORDING to a communication to the Geological Society of Hungary, the remains of a man, associated with post-tertiary remains of mammalia, together with a stone hammer, have lately been discovered in the loess deposits of Hungary, in the neighbourhood of Brux, in Bohemia. These were in nearly a complete condition. The cranium strongly resembles in its characteristics the well-known fragment from the Neanderthal, although differing in certain peculiarities mentioned in the article. The skeleton was found lying with the head raised, in a sand-bed of diluvial age, at a depth of two feet from the surface.

IN making an excavation on the banks of the Amoor River, *Harper's Weekly* states that a stone axe of nephrite, or jade, and beautifully finished, was found at a depth of about three feet. This fact is the more interesting as it bears upon the question in regard to the celebrated stone-tipped arrows which were used by the primeval inhabitants of Mantchuria as late as the twelfth century. It was with arrows winged with eagles' feathers and tipped with nephrite points that this people paid their tribute to China while they were under its dominion. The precise locality of nephrite in Mantchuria is unknown, although it is stated by some to have been on a mountain to the north-west of that country.

THE Perthshire Society of Natural Science held its Annual Meeting on March 7, when Colonel H. M. Drummond Hay was elected president in the room of Dr. Buchanan White, who has held the office for five years. This enterprising society must be congratulated on the work it has done in the exploration of the natural history of the county, and in the commencement of the publication of so valuable a work as the *Fauna Perthensis*, and the promotion of so useful a periodical as the *Scottish Naturalist.* Botany seems, however, up to the present time, to have been neglected by the Society, which is to be regretted in a county with so rich and interesting a flora. The Society has also held "a meeting for investigation into the qualities, as articles of food, of certain Perthshire animals," commonly known as a "Frog-supper." Among the articles of the bill of fare were—Pâté d'Ecureuil, Matelot de Grenouille, Alouette à la Crapaudine, Ecureuil au naturel.

AN Act passed by the Governor-General of India in Council in October last, with a view to provide for the ultimate adoption of a uniform system of weights and measures of capacity throughout British India, has been laid before the House of Commons. The Act directs that the unit of weight shall be a "ser," equal to the French kilogramme, and the unit for measures of capacity, a measure containing one such ser of water at its maximum density, weighed in a vacuum. Other weights and measures of capacity, to be authorised under this Act, are to be integral multiples or sub-multiples of their units, the sub-divisions to be expressed in decimal parts unless otherwise ordered. When proper standards have been provided for verification of these weights and measures to be used by any Government office, municipal body, or railway company, the Governor-General in Council may direct that the weights and measures as authorised shall be used in dealings by such office, body, or company. The local Government may prepare tables of the equivalents of other weights and measures in terms of the weights and measures so authorised.

DR. W. LAUDER LINDSAY announces as in preparation, "Mind in the Lower Animals," a popular exposition of those traits in the habits of animals that illustrate their possession of the higher as well as the lower faculties of mind, as it exists in man. Dr. Lindsay has already written extensively on the subject in the *Journal of Mental Science* and the *British and Foreign Medico-Chirurgical Review.*

THE second enlarged and improved edition is published of Dr. O. W. Thomé's "Lehrbuch der Botanik," intended especially for elementary classes of botany in gymnasia and public schools. Although some portions of the work, especially the systematic, are open to exception, yet it presents the elements of the different departments of botanical science in a more compact form, and at a lower price (3*s.*) than probably any other work. It is illustrated by nearly 900 woodcuts.

MR. SHIRLEY HIBBERD has in the press a volume entitled "The Ivy, a Monograph," which will shortly be published by Messrs. Groombridge and Sons.

A USEFUL catalogue is published at Ghent, entitled, "Nomenclature usuelle de 550 Fibres Textiles, avec indication de leur provenance, leurs usages," &c., by the conservator of the commercial-industrial museum in that city.

MESSRS. GROOMBRIDGE AND SONS are preparing a new edition, with coloured plates, of Mr. Lambton J. H. Young's "Sea Fishing as a Sport."

MR. B. S. LYMAN, mining engineer to the Public Works Department of the Government of India, reprints from the "Transactions of the American Philosophical Society" an account of the Punjab Oil Region, accompanied by a geological and topographical map.

ANNUAL ADDRESS TO THE GEOLOGICAL SOCIETY OF LONDON, FEB. 16, 1872

BY J. PRESTWICH, F.R.S., PRESIDENT

(*Continued from page* 433.)

IT has been already mentioned that below a certain level permeable strata are necessarily always saturated and water-logged, and that any additional quantity added to this constant quantity cannot be held permanently. It follows that wherever, in all water-bearing strata, after allowing for any abstraction, usually but comparatively small, by wells, the surplus rainfall must, when the stratum is full, find its escape by natural means, *i.e.*, by means of springs. The power and size of these are necessarily dependent upon the dimensions of the strata by which they are supplied. In the gravel they are small, in the Lower Tertiary sands moderate; while in the Chalk they are very large. The permanence of the spring depends on the lithological character as well as on the dimensions of the strata. Thus, in sands, where the water can permeate the mass, the stores are large, and the delivery moderately quick; in Limestones, where the water is confined to cracks and fissures, the delivery is quick and not lasting, though often large; in rubbly Oolites, which are also practically porous, the springs are well maintained; while in Chalk, owing to the characters before named, the water-delivery is slow, and the springs are large and very permanent.

At the same time the storage-capacity increases with the resistance. Taking the extreme case of the Chalk, the transmission of the rain-water is so slow, that, on the chalk hills, it takes four or six months to pass from the surface to the line of water-level at the depth of 200ft. to 300ft., so that the heavy rainfall of winter is not felt in the deep springs until the summer, and Mr. Beardmore estimates that the minimum effect of a hot dry summer and autumn is not reached until at the end of about sixteen months, or that the storing-power of the chalk is of sixteen months' duration. To estimate this power, we have to take the height and extent of the hills, and to note the lithological characters of the permeable strata. If these latter are underlaid by impermeable strata at above the level of the rivers in two adjacent valleys, then the base of the underground water-store will be coincident with the level of the impermeable strata, and its surface-line will rise, as it recedes within the hill, in proportion to the resistance offered to the water's escape by the character of the permeable strata, and it will thus form a curve between those two points, the height of which will vary in proportion to the rainfall. When, on the other hand, the permeable strata continue down to a greater or less depth beneath the surface of the adjacent rivers, then, as there is no underground escape for the stored water, the line of water-level in those permeable strata will rise to, and be always maintained at, the level of the rivers, and therefore all the additional supplies furnished by the rain must, after traversing the interior of the hills, find an escape along the bottom of the valleys, and by the side or in the bed of those rivers. In the dry upland valleys of the Chalk and Oolites, the underground water, dammed back by the streams in the nearest river-valley, passes under those valleys at depths varying with the resistance offered by the lithological character of the formation, and by the gradient of the valley as it runs into the hills.

When again, as in the case of the chalk downs and oolite hills, the exterior outcrop of the permeable strata rests on impermeable strata at a height above the river-levels, and in the other direction inwards they pass below similar levels, then the springs partake of the same divided character—the one smaller set flowing out on the sides of the hills, and the stronger and more lasting springs issuing, as it were, at the foot of the incline on the level of the rivers. In any case, it is the distance between the two points of escape that gives us one measure of storage. If the distance is reckoned by miles, then the rise of the water-level may be measured by tens of feet. It is highest when both the distance from the adjacent river-valleys, and at the same time the height of the hills is greatest. In some instances, the crown of the arch formed by it will rise to a height of from 60 ft. to 80 ft. above its chord.

This curve is subject to great fluctuation, varying according to the seasons and amount of rainfall. Mr. Clutterbuck has shown that, in the chalk hills of Hertfordshire, its height varies as much as 30 ft. or 40 ft. From the crown or centre of its summit it decreases at a rate varying generally from 3 ft. to 30 ft., or even more, per mile to all parts of the circumference. The height of the arch and the breadth of the base-line, taken together, give therefore the head of water supplying the large springs of the Chalk—such as those of Chadwell, Hoddesden, Otter, Carshalton, Leatherhead, Ospringe, and others. But, besides these, there are innumerable smaller ones, not so easily seen, flowing out on the sides, or in the beds of the rivers traversing the great permeable formations, as the many along the Thames from Greenhithe to Faversham, on the Upper Lea and its tributaries, and on the Medway and the Darent, where they traverse the chalk hills. This class of springs has especial geological bearings, which we shall hereafter have occasion to dwell upon.

The same general rules govern the springs of all the more varied strata of the upper part of the Thames basin, where, in place of the Cretaceous and Tertiary series, we have a series of Jurassic and Liassic strata. Omitting the drift or gravel beds, the following are the average dimensions, character, and superficial areas of each of these formations in that area:—

STRATA OF THE THAMES BASIN ABOVE WALLINGFORD

	Area.	Average Thickness.	
	Square miles.	Permeable strata.	Impermeable strata.
Chalk (above Kingston 1047)	60	1000	—
Upper Greensands ...	62	100	—
Gault ...	129	—	130
Lower Greensands ...	23	200	—
Purbeck and Portland beds	46	60	—
Kimmeridge Clay ...	132	—	300
Coral Rag and grit...	103	40	—
Oxford Clay ...	307	—	400
Great and Inferior Oolites...	327	450	—
Fuller's Earth ...	16	—	40
Lias ...	170	—	500

But although many of these water-bearing strata are of large dimensions and well stored in the upper part of the Thames basin, none of those below the Gault, except the Lower Greensand, are available for a well-supply at London. The Upper Greensand, so important in Wiltshire, is reduced to a few feet of comparatively impermeable argillaceous sands under London. The Oolitic series, so rich in springs in the district of the Cotswold Hills, have been ascertained to thin off as they range eastward; and Mr. Hull has shown that the inferior Oolite and underlying sands in particular die out in all probability, under the Oxford clay about the centre of Oxfordshire. Even apart, therefore, from the discovery made at Kentish Town, we should now have excluded the Oolitic series as a possible source of supply to deep wells in the London district; although, as sources of springs' supplies, they contribute so important a share to the maintenance of the Thames. Few of those strata are, however, so homogeneous as the Chalk and the London Clay. The permeable formations often contain subordinate impermeable clays—seams which form water-levels of more or less importance, whilst the impermeable clays sometimes contain subordinate beds of sand or of rock which constitute small local water-bearing beds. It is for the geologist to assign its relative value to each of these subordinate features, and to distinguish the minor from the major sources.

Taking the Thames basin above Kingston, there is, according to Mr. J. D. Harrison, an area of 1,233 square miles of impermeable strata, and of 2,442 miles of permeable strata, and the mean annual rainfall in that district amounts to about 27 inches. From the impermeable strata the rain flows off immediately as it falls, and is carried at once to sea; whereas a large portion of that which falls on the permeable strata is, as we have shown, stored for a greater or lesser time, and discharged in perennial springs. It is these which give permanence to our rivers. The evidence taken before the Commission showed that the daily discharge of the Thames at Kingston, even in the driest season after weeks without rain, never falls below 350,000,000 gallons, while the average for the year gives, according to Mr. Simpson and Mr. Harrison, 1,353,000,000 gallons, or, according to Mr. Beardmore's longer observations, 1,145,000,000 gallons daily, the mean of 1,250,000,000 gallons being equal to a fall of about 8 in., or rather less than one-third of the annual quantity, the other two-thirds being lost by evaporation and absorbed by the vegetation. This seems the proportion usual under the like general conditions in these latitudes. M. Belgrand has shown, in "La Seine," that in the upper basin of the Seine there are 19,390 square kilometres of impermeable, and 59,210 of per meable strata; and careful measurements have proved that the discharge at Paris is also equal to about one-third of the rainfall. The exact proportion of the rainfall passing into the different permeable strata, and given out again in the form of springs, has yet to be accurately determined. Mr. Harrison estimates it in the Thames basin at about one-sixth of the rainfall.

In districts where impermeable strata predominate, the total water delivery, therefore, will be greater; but it follows close upon the rainfall; whereas, where the permeable strata predominate, a large portion of the rainfall is stored in the hills, and its delivery is thereby spread over a greater or lesser period of time, according to the dimensions of those hills. This is well exemplified in the case of the basins of the Thames and the Severn, which latter is formed in large part by the slate rocks of Wales. The former has an area above Kingston of 3,670 square miles, with an annual rainfall of 27 inches; whereas that of the latter above Gloucester has an area of 3,890 miles, with an average rainfall of probably not less than 40 inches, and the mean daily discharge for the year is for the Thames of 1,250,000,000 gallons, and for the Severn about 1,600,000,000 gallons. Yet the summer discharge of the Thames averages 688,700,000 gallons daily, against 297,599,040 gallons of the Severn; and while the minimum discharge of the Thames in the driest seasons never falls below 350,000,000 gallons, that of the Severn falls below 100,000,000 gallons. Again, in the case of the Lea, where there is a still larger proportion of permeable strata, the daily discharge at Broxbourne for the year is, according to Mr. Beardmore, 108,000,000 gallons, while for the summer months it remains as high as 71,000,000, and in the driest seasons does not fall below 42,000,000 gallons.

Let us now look at one of the geological questions dependent upon the solvent action of the water on the strata it traverses. The analyses, made for the Commission by Drs. Frankland and Odling, of the waters of the Thames and its tributaries in the Oolitic and Chalk area, show that every 100,000 parts or grains of rainwater has taken up a quantity varying from 25·58 to 32·95 grains of solid residue, or an average of 29·26, which is equal to 20·48 parts or grains per gallon; another analysis of the Thames water at Ditton gives 20·78 grains per gallon of solid residue. It was also shown by Drs. Letheby and Odling and Prof. Abel that the unfiltered waters of the Thames Companies, which take their supplies above Kingston, contained 20·82 of solid residue. If from the average of 20·68 we deduct 1·68 grain for organic and suspended matter, we have 19 grains of inorganic residue for every gallon of water flowing past Kingston. This is of course apart from the sediment carried down in floods. The ordinary monthly analyses, conducted by the same eminent chemists during the course of several past years, show that this quantity is liable to very little variation, the only difference being that it is somewhat larger in winter and less in summer.

Some general estimates have already been made by Profs. Ramsay and Geikie of the quantity of mineral matter carried down in solution by the Thames; but the more exact data supplied to the Commission enable us to make some additions to previous results. Taking the mean daily discharge of the Thames at Kingston at 1,250 million gallons, and the salts in solution at 19 grains per gallon, the mean quantity of dissolved mineral matter there carried down by the Thames every twenty-four hours is equal to 3,364,286 lbs. or 1502 tons, or 548,230 tons annually. Of this daily quantity about two-thirds, or 1,000 tons, consist of carbonate of lime, and 238 tons of sulphate of lime, while limited proportions of carbonate of magnesia, chlorides of sodium and potassium, sulphates of soda and potash, silica and traces of iron, alumina, and phosphates, constitute the rest. If we refer a small portion of the carbonates, and the sulphates and chlorides chiefly, to the impermeable argillaceous formations washed by the rain water, we shall still have at least 10 grains per gallon of carbonate of lime, due to the Cretaceous and Oolitic strata and Marlstone, the superficial area of which, in the Thames basin above Kingston, is estimated by Mr Harrison at 2,072 square miles. Therefore the annual quantity of carbonate of lime carried away from this area by the Thames is 29 905 tons, or 797 tons daily, which gives 140 tons removed yearly from each square mile; or extending the calculation to a century we have 14 000 tons removed from each mile of surface. Taking a ton of chalk as equal to 15 cubic feet this is equal to a removal of $\frac{9}{100}$ of an inch from the surface in the course of a century, so that in the course of 13,200 years a quantity equal to a thickness of about one foot would be removed from our Chalk and Oolitic districts.

I had some faint hope that this wear might furnish us with a rough approximate measure of time in reference to some of the phenomena connected with the Quaternary period; but we are not in a position to apply it. Those curious funnel-shaped cavities, called sand and gravel-pipes, so common in many chalk-districts, are the result of slow solution of the chalk by water at particular spots, whereby the superincumbent sand and gravel have been let down into the cavity so produced. Some of them are but a few feet deep, while others attain dimensions of 80 feet in depth by 15 to 20 feet in diameter at top, tapering irregularly to a point at bottom. It is, however, evident from the variation in size that the wear has been unequal; and it is also clear that the surface-waters have been conducted through these particular channels, where they existed, to the underground water level, in preference to passing through the body of the chalk, so that the ratio of wear at these points is in excess. Nor can I see at present how otherwise to apply this measure. If it were possible to find a spot where the exposed surface of the chalk has been worn uniformly, and, from the quantity of flints left after the removal of the chalk and the known distance apart thereof the seams of flint, to determine the number of feet or inches removed, we might have a base to proceed upon, provided all the quantities remained constant. But such is not the case. Also, although the annual rainfall in the Thames now averages 27 inches, and has probably not varied much from this amount during the present period, it was evidently much greater during the Quaternary period; for I have elsewhere shown that, in the South of England and North of France the rivers of those areas with the same catchment-basins were of much greater size than at present; and Mr. W. Cunnington had before pointed out the same fact in the upper part of the basin with respect to some of the rivers of Wiltshire. M. Belgrand has made an attempt to estimate this quantity with reference to the Seine and its tributaries, and he arrives at the conclusion that, during the Quaternary (or, as he considers it, the Glacial) period, the rainfall was so heavy, that the discharge of the river was from 20 to 25 times greater than at present. I do not altogether concur in this view, but I can conceive that our rivers formerly were of five or six times the size they now are. This is an important element to be considered in all questions bearing on the denudation of land-surfaces.

There is yet another point which, although not in our direct field of research, yet depends so essentially upon the geological conditions we have discussed, and is one, in a public point of view, of such paramount importance, that I will, with your permission, say a few words on the subject. In an uninhabited country, the rain passes through the soil and issues as springs, bearing with it a certain proportion of mineral matter, and only traces of such organic matter as existed on the surface. This would be solely of vegetable origin, and the proportion would be in most cases very small. As man appeared, those conditions would be at first but little altered, for animal matters exposed on the surface rapidly decay and pass away in a gaseous form; but with increasing civilisation and fixed residences the necessity of otherwise getting rid of all refuse would soon be felt. I have shown how population followed the range of shallow permeable strata and the course of valleys, so as to obtain readily that indispensable necessity of life, a sufficient water supply. But with the art of well-digging it soon became apparent that, let the well be carried down but half way to the level of ground-springs, it would remain dry, and that then, so far from holding water, any water now poured into it would pass through the porous strata down to the water-level beneath, keeping the shallower well or pit constantly drained. So convenient and ready a means of getting rid of all refuse liquids was not neglected. Whilst on one side of the house a well was sunk to the ground-springs, at a depth, say, of twenty feet, on the other side a dry well was sunk to a depth of ten feet, and this was made the receptacle of house-refuse and sewage. The sand or gravel acting as a filter, the minor solid matter remained in the dry well, while the major liquid portion passed through the permeable stratum and went to feed the underlying springs. What was done in one house was done in the many; and what was done by our rude ancestors centuries back has continued to be the practice of their more cultivated descendants to the present day, with a persistency in the method only to be attributed to the ignorance of the existence of such a state of things among the masses, and to the ignorance of the real conditions and actual results of perpetuating such an evil—an evil common alike to the cottages of the poor and, with few exceptions, to the mansions of the rich.

Instances occur from time to time to point out isolated consequences of this pernicious practice, but I believe no one who has not gone into the geological question can realise its magnitude. It is not confined to one district or to a few towns or villages. It is the rule, and only within the last few years have there been any exceptions. The organised supply of water now furnished by companies in all large towns has, to a great extent, done away with the evil in those situations (though the root of the mischief has too often been left unextracted); but in villages and detached houses, great or small, it remains untouched and unchecked. Not a county, not a district, not a valley, not the smallest tract of permeable strata, is free from this plague-spot. It haunts the land, and is the more dangerous from its unseen, hidden, and too often unsuspected existence. Bright as the water often is, without objectionable taste or smell, it passes without suspicion until corrupted beyond the possibility of concealment by its evil companionship. Damage, slight in extent, or unimportant possibly for short use, but accumulative by constant use, may and does, I believe, pass unnoticed and unregarded for years. Nevertheless the draught, under some conditions, is as certain in its effects, however slow in its operation, as would be a dose of hemlock. Go where we may, we never know when the poisoned chalice may be presented to our lips. The evil is self-generating; for the geological conditions supplying our necessities lend themselves to its maintenance and extension. The knowledge necessary to remedy it is of very slow growth, and the too frequent want of that knowledge, or disregard of the subject, even amongst able architects and builders, is such that, without legislative enactment, I do not see how the evil is to be eradicated for many a long term of years.

This also is only one form of the evil—it is that where the water-bearing strata are thin and the wells do not exceed a depth of thirty feet. It was the one which prevailed in London, and in towns similarly situated, up to a very few years back. It even still lingers on in some private wells, and is moreover fostered among us by the bright-looking and cool water of too many of our public pumps; for not only does the ground still suffer from the effects of the original contamination, but also from much, almost inevitable, obnoxious surface-drainage, much gas escape, much rainfall on old open churchyards, which find their way to the one level of water supplying in common all these shallow wells. The evil still exists also, although to a less extent, in towns where the wells have to be carried to much greater depths; its effects varying according as the depth, and as the volume of the springs is to the sewage-escape; it is, however, only a question of degree.

But even our deeper and apparently inaccessible springs have not escaped contamination. As before mentioned, the underground water will, when tapped by artesian wells, rise to or above the surface, according to the relative height of the surface of the ground at the well, and of the outcrop of the water-bearing bed or beds, so that if the former is higher than the latter, or if by artificial means the line of water-level in a given area becomes lowered, then the surface of the water belonging to those great underground natural reservoirs will be established accordingly at a certain fixed depth beneath the surface. As each well deriving its supply in a stratum of this description represents a column of water communicating with one common reservoir, it follows that any cause permanently lowering the level of one well will tend to lower the level in the other wells in proportion to their number and distance. Further, it has been discovered that a well of this class can absorb a quantity of water equal to that which it can furnish; and as these wells give greater supplies than shallow wells, the absorbing wells of the same class are alike powerful in proportion to the others. The perverse ingenuity of man has here, again, taken advantage of these conditions to get rid of offensive waste waters by diverting them into such deep wells, whence they pass away in hidden underground channels, unseen and unsuspected, and mingle with those deep-seated water-sources feeding the artesian wells dependent upon them for their supply.

In Paris, where there are several alternating beds of permeable and impermeable strata, and the depth to reach them is not very great, this system of absorbing wells connected with factories became, until regulated by the municipality, very common, to the great injury of many of the underground springs. From this and the other causes before alluded to, a great number of shallow wells have there become so contaminated as to necessitate their abandonment. Our own system of surface-drainage is generally too good, and the depth to the lower water-bearing strata too great, to have rendered the use of such wells here equally advantageous; nevertheless, I have reason to believe that they do exist, and that the sources even of our deep well-water supply in the Lower Tertiary Sands and in the Chalk are thus to some extent polluted and injured.

Nor do the great and perennial springs supplying our rivers altogether escape the evils arising from these obnoxious practices. On the high Oolitic ranges and amongst the undulating Chalk hills, the line of water-level is often so deep below the surface, that only in few cases are wells made—the population being generally dependent on rainwater for their water-supply. But this does not prevent the construction of dry wells for the disposal of sewage and refuse. It is true that the population in these hills is sparse—here and there a farm, a few cottages, and scarcely a village. Still as the ground is everywhere absorbent, and there are no streams even in the valleys (I am now speaking of the higher districts), every dwelling contributes its quota; for the rain and all liquid matter absorbed in these strata necessarily pass down to the great underground reservoirs of water feeding the springs thrown out in the deeper river-valleys. In these cases, however, the thickness of strata through which any liquid has to pass before reaching the line of water-level is such as to produce a more or less efficient filtration and complete decomposition; and as the injury caused is in proportion to the relative volumes of the water-sources and to the artificial additions, the great extent and dimensions of these water-bearing strata and the scanty population of such districts reduce it to a minimum.

Owing to these conditions, great as the evil is, experience teaches that it has, in some cases, its vanishing-point. It may be considered at its maximum in some of the wells of Paris; our own London shallow-well pumps follow next in order; in our river-waters away from towns it is but slight; in some of the springs of the Chalk and Lower Greensands it is hardly appreciable, while in the deep well-waters, especially those of Caterham and Grenelle, it sinks to the minimum attained by any potable waters, with the exception of rain-water. It is also a fortunate circumstance that the wonderful powers of oxidation possessed by air and water, and the powers of absorption and decomposition by soils and earths, are such as, even in the surcharged gravel-bed of London, to remove all the more offensive characters, and leave its spring-waters at all events limpid and bright; whilst the quick eddy, the moving ripple, the bright sunshine, the brisk breeze, the living organisms, are ever at work in our rivers, destroying the almost inevitable accompaniments of the presence of man, and restoring the waters to that original state of purity so essential to his health and welfare.

It was on considerations of quantity of supply thus dependent on geological conditions, and of quality as dependent jointly on geological and artificial conditions, that the Commission was mainly so long and assiduously engaged. With regard to the character of waters as dependent on the geological nature of the strata, while the evidence showed that the waters flowing off hard and insoluble rocks were, from their much greater freedom from mineral matter, more economical for many domestic and manufacturing purposes, yet that for drinking purposes, waters such as those derived from our Chalk and Oolitic districts were, on the whole, as good and wholesome as those from any other sources; while as regards quantity and permanence, the conditions presented by a large catchment-basin of a varied geological structure presented the most favourable conditions for the large and maintained supply so essential for a great city. And if, from any cause, it should at some future time be thought desirable to have a supply of a yet more assured and undoubted quality than a river supply, the large springs of the chalk and the Lower Greensand, or the great underground reservoirs of the most efficiently filtered water stored in those formations in Surrey and Hertfordshire, might, I believe, be resorted to with advantage, by means of ordinary and artesian wells, as auxiliary sources of supply for domestic and drinking purposes, supposing the engineering difficulties connected with a double water-supply could be overcome—a difficulty which it, however, seems to me would possibly be less one of construction to our engineers than of cost to the public. But in a great health-question there are other considerations than these which are of more primary importance.

(To be continued.)

SCIENTIFIC SERIALS

Journal of the Franklin Institute, November 1871.—The editorial notes in this number are as usual very instructive;

amongst them we must notice Young's catalogue of the bright lines observed in the chromosphere of the sun, which have already reached a goodly number. Under Civil and Mechanical Engineering there are several useful and interesting articles, such as "On Woodworking Machinery," "On the Flow of water in rivers and canals," &c.—Prof. Cooke contributes the first of a series of papers "on the chemical theory of the Voltaic Battery." The present communication, however, deals with preliminary matters; it discusses molecules, atoms, and the quantivalence of elements. The paper which follows is "On some improvements in reflecting Telescopes," by J. A. Hill. The author proposes, in the first instance, to reflect the light from a movable plane mirror placed in the axis of the speculum, which receives the reflected rays; the convergent beam from the speculum passes through an aperture in the centre of the plane mirror, and can be received in a suitable eye-piece; no tubes are used, so that by this method it would be as easy to handle a mirror of 1,000 feet focal length as one of the same size of 50 feet focal length. The observer, too, would remain stationary, and need not be hoisted into mid-air.—Prof. Young continues his Spectroscopic Notes; this month's contribution is "on the construction, arrangement, and best proportion of the instrument, with reference to its efficiency." Under this head come the best angle and material for the prisms, the means of testing for flatness of surface and homogeneity of substance, and the number and arrangement of the prisms; there are also two other sections, "on dispersive efficiency and on luminous efficiency." A suggestion of a new form of chemical spectroscope is given, the dispersive part of this consists of two prisms, which are each concave on one side, and are cemented to the convex object-glasses of the collimator and observing telescope. By this it is hoped to save both material and light.

THE *Geological Magazine* for March (No. 93) opens with a new species of *Rostellaria* (*R. Pricei*) from the Grey Chalk of Folkestone, by the editor, Mr. H. Woodward.—Mr. A. H. Green communicates a paper on the method of formation of the Permian beds of South Yorkshire, in which he discusses the general arrangement and palæontology of these beds, and deduces from them a confirmation of Prof. Ramsay's theory that the Magnesian Limestone and associated beds of this part of England were formed in part by chemical precipitation in an inland sea.—Prof. H. A. Nicholson records the occurrence of the Cephalopod *Endoceras proteiforme* Hall, in Britain; the specimen described and figured was discovered by the author in the mudstones of the Coniston series near Ambleside, a set of rocks in which scarcely any fossils, except Graptolites, have hitherto been found.—Mr. James Geikie gives a fourth paper on Changes of Climate during the Glacial Epoch, in the conclusion of which he sums up his views as to the sequence of climates at this time as follows:—1. A succession of alternate glacial and temperate conditions, but associated with the great Continental ice-sheets; 2, a temperate climate, with removal of the ice-sheets from low grounds; 3, a period of subsidence, with temperate climate, and much denudation of moraines; 4, a period of emergence, with arctic conditions, floating ice dispersing erratics, and deposition of clays with arctic mollusca; and, 5, a period of local glaciers in Britain and Ireland, with gradual amelioration of climate. In future papers the author proposes to discuss the cave-deposits and older river-gravels of England. The post-glacial geology and physiography of West Lancashire and the Mersey estuary, form the subject of an interesting paper, by Mr. T. Mellard Reade; and Prof. T. Rupert Jones and Mr. W. K. Parker give us the corrected nomenclature of the Foraminifera from the English Chalk, figured by the Rev. Henry Eley in 1859.—The number also contains an abstract of an address on subsidence as the effect of accumulation, read before the Liverpool Geological Society, by Dr. Charles Ricketts.

THE *Journal of Botany* for March contains only one original article bearing specially on British Botany, Notes on the British *Ramalinæ* (a genus of Lichens) in the Herbarium of the British Museum, by the Rev. Jas. Crombie. We find also, "On *Symea*," a new genus of triandrous *Liliaceæ* from Chili, by Mr. J. G. Baker, with a plate; recent researches into *Diatomaceæ*, by the Rev. E. O'Meara; and *Castanea vulgaris* grown in Southern China, by Dr. Hance. Mr. Carruthers contributes his important Review of the Contributions to Fossil Botany published in Britain in 1871; and the editor commences in this number a valuable list of the articles contained in the German botanical journals for January.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, Feb. 29.—"On the Relative Power of Various Substances in arresting Putrefaction and the Development of Protoplasmic and Fungus Life;" by Dr. F. Crace-Calvert, F.R.S.

March 14.—"Contributions to the History of the Opium Alkaloids," part iv.; by Dr. C. R. A. Wright.—"The Decomposition of Water by Zinc in conjunction with a more Negative Metal;" by J. H. Gladstone, F.R.S., and Alfred Tribe, F.C.S.

March 21.—"On some Heterogenetic Modes of Origin of Flagellated Monads, Fungus-germs, and Ciliated Infusoria," by Professor H. Charlton Bastian, F.R.S. In this communication Dr. Bastian announces results which, whilst confirming the previous observations of MM. Pineau and Pouchet, considerably extend our knowledge concerning the heterogenetic changes liable to take place in the pellicle (composed of aggregated Bacteria) which forms upon an infusion of hay. He describes all the stages by which certain Fungi, Flagellated Monads, and Ciliated Infusoria are produced, as a result of changes taking place in the very substance of the pellicle. Most of the observations were made under a magnifying power of 1,670 diameters, and, although more extensive, are confirmatory of others published in NATURE, No. 35. Dr. Bastian says, "I now wish to describe other allied processes, and the means by which I am enabled to obtain, almost at will, either animal or vegetal forms from certain embryonal areas which are produced in the pellicle." The simplest mode of origin of Fungus-germs and Monads is thus described:—"The pellicle which formed on a filtered maceration of hay during frosty weather (when the temperature of the room in which the infusion was kept was rarely above 55° F., and sometimes rather lower than this) presented changes of a most instructive character. On the third and fourth days the pellicle was still thin, although on microscopical examination all portions of it were found to be thickly dotted with embryonal areas. Nearly all of them were very small; but a few areas of medium size were intermixed. The smallest were not more than $\frac{1}{4000}''$ of an inch in diameter, and these separated themselves from the pellicle as single corpuscles; slightly larger areas broke up into two or three corpuscles; and others, larger still, into 4—10 corpuscles. In most of these small areas, the corpuscles were formed with scarcely any appreciable alteration in the refractive index of the matter of which they were composed; this simply became individualised, so that the corpuscles separated from the surrounding pellicle and from their fellows, still presenting all the appearance of being portions of the pellicle, and exhibiting from 4 to 10 altered *Bacteria* in their interior. In some cases the products of segmentation soon developed into actual flagellated Monads in a manner presently to be described; whilst in others they seemed to remain for a longer period in the condition of simple motionless corpuscles. Other solitary corpuscles or small areas began to form in the pellicle in precisely the same manner, though they speedily assumed a highly refractive and homogenous appearance. Why some should undergo such a change, and not others, seems quite impossible to say. One can only assert the fact, and add that these highly refractive ovoid corpuscles were, for the most part, more prone to produce Fungus-germs than Monads. Many of them soon grew out into dissepimented fungus filaments, which rapidly assumed the *Penicillium* mode of growth. The spores, which were abundantly produced in terminal chaplet-like series, were, however, small, homogeneous, spherical, and colourless." In other cases Monads and Fungus-germs are produced from the pellicle in precisely the same manner as that by which they arise within the terminal chambers of certain Algæ or Fungi—that is to say, they result from the segmentation of a mass of homogeneous protoplasm.

In speaking of such a mode of origin of Monads, Dr. Bastian says:—"Contrasting with the very pale fawn-colour of the evenly granular pellicle, there were numerous areas of a whitish colour, refractive, and more or less homogeneous. These areas differed very much in shape and size; some were not more than $\frac{1}{1000}''$, whilst others were as much as $\frac{1}{150}''$ in diameter. Their shape was wholly irregular. As in the instances previously recorded, the first appreciable stage in the formation of an embryonal area in the pellicle was a local increase in the amount of gelatinous material between the units of this portion of the pellicle, so that they became more distinctly separated from one another than in adjacent parts. Gradually these particles became less sharply defined, and at last scarcely visible, in the midst of a highly refractive protoplasmic mass which began to exhibit traces of segmentation. Masses of this kind were seen, which had been resolved by such a process of segmentation into a number of spherical corpuscles about $\frac{1}{4500}''$ in diameter. These were at first highly refractive, though they gradually became rather less so, and revealed the presence of two or three minute granules in their interior. In other adjacent areas, a number of densely-packed, pliant, and slightly larger corpuscles were seen actively pushing against one another. When they separated, they were found to be active ovoid specimens of *Monas lens*, about $\frac{1}{5000}''$ in length, and provided with a vacuole and a rapidly lashing flagellum."

In other cases embryonal areas of the same nature were formed, which went through similar processes of segmentation; although the units produced, instead of developing into Monads, were seen to become transformed into brown vesicular bodies, which subsequently germinated into Fungus filaments. Whilst affirming that he is now able to determine pretty surely the occurrence of either one of these phenomena, Dr. Bastian says:—

"Experience has shown me, that, if an infusion has been heated for a time to 212° F., the pellicle which forms on its surface very frequently never gives rise to an embryonal area. If the infusion has been prepared at a temperature of 149°—158° F., the embryonal areas which form will give origin to Fungus germs; whilst in a similar infusion prepared at 120°—130° F., the embryonal areas, which seem at first to be in all respects similar, break up into actively moving Monads."

Dr. Bastian then proceeds to give an account of the origin of *Paramecia*, laying stress upon the fact that, in order to obtain such organisms, it is necessary to employ a filtered infusion made with cold water. His observations on this subject were, in the main, confirmatory of those of M. Pouchet. Thousands of egg-like bodies, varying in size from $\frac{1}{500}''$ to $\frac{1}{250}''$ were seen developing throughout the whole substance of a thick pellicle. He says: "It seemed to me that the differentiation took place after a manner essentially similar to that by which an ordinary 'embryonal area' is formed. The small embryos did not appear to represent the earlier stages of large embryos; and it seemed rather that spherical masses of the pellicle of different sizes began to undergo molecular changes, which terminated in the production of *Paramecia* of a correspondingly different bulk. Just as in the previously described embryonal areas masses of different sizes began to exhibit signs of change, so also here, spherical portions of the pellicle, differing within the limits above mentioned, began to undergo other heterogenetic changes. This was first indicated by an increased refractiveness of the area (especially when seen a little beyond the focal distance); and almost simultaneously a condensation of its outer layer seemed to take place, whereby the outline became sharply and evenly defined. At this stage an actual membrane is scarcely appreciable, and the substance of the embryo (when examined at the right focal distance) scarcely differs in appearance from the granular pellicle of which it had previously formed part. So far as it could be ascertained, the individual embryos did not increase in size, although they went through the following series of developmental changes. The contained matter became rather more refractive, and the number of granules within diminished considerably, whilst new particles after a time seemed gradually to appear in what was now a mass of contractile protoplasm. These new particles were at first sparingly scattered, though as they were evolved they continued to grow into biscuit-shaped bodies, which sometimes attained the size of $\frac{1}{10000}''$. All sizes were distinguishable; and many of them moved slowly amongst one another, owing to the irregular contractions of the semi-fluid protoplasm in which they were embedded. Gradually the number of homogeneous biscuit-shaped particles increased; and at last a large vacuole slowly appeared in some portion of the embryo. It lasted for about half a minute, disappeared, and then, after a similar interval, slowly reappeared. Much irregularity, however, was observed in this respect. The next change that occurred was the complete separation of the embryo from the cyst which it filled, and the commencement of slow axial rotations. These rotations gradually became more rapid, though they were not always in one direction. The mass became more and more densely filled with the large biscuit-shaped particles, and at last the presence of cilia could be distinctly recognised on one portion of the revolving embryo. Then, as M. Pouchet stated, the movements grew more and more irregular and impulsive, so as at last to lead to the rupture of the thin wall of the cyst—when the embryo emerged as a ciliated and somewhat pear-shaped sac, provided with a large contractile vesicle at its posterior extremity. . . . On emerging from the cyst, all the embryos, although differing somewhat in size, were of the same shape. This closely corresponded with the description given of *Paramecium colpoda* in Pritchard's 'Infusoria,' namely:—'Obovate, slightly compressed; ends obtuse, the anterior attenuated and slightly bent like a hook.' Cilia existed over the whole body, though they were largest and most numerous about the anterior extremity. No trace of an actual buccal cleft could be detected; and (except in the posterior portion of the body, where a large and very persistent vacuole was situated) the organism was everywhere densely packed with the large, homogeneous, biscuit-shaped particles. For many days these most active Infusoria seemed to undergo little change, though afterwards the number of the contained particles gradually began to diminish, whilst the body became more and more regularly ovoid, and a faint appearance of longitudinal striation manifested itself, more especially over its anterior half. At the same time a very faint and almost imperceptible mass ('nucleus') began to appear near the centre of the organism; and when examined with a magnifying power of 1,670 diameters, a lateral aperture (mouth) $\frac{1}{8000}''$ in diameter was seen, which was fringed by short active cilia, arranged like the spokes of a wheel. These peculiarities correspond very closely with those of an embryo *Nassula*. Very many were seen with similar characters; and multitudes existed in all conditions intermediate between this stage and that of the simpler organism which first emerged from the cyst."

Dr. Bastian concludes by saying:—

"It will, of course, be seen that the phenomena which I have described as taking place in the 'proligerous pellicle' may be watched by all who are conversant with such methods of investigation. We do not require to call in the aid of the chemist; we need exercise no special precautions; the changes in the pellicle are of such a kind that they can be readily appreciated by any skilled microscopist.

"Just as I have supposed that living matter itself comes into being by virtue of combinations and re-arrangements taking place amongst invisible colloidal molecules, so now does the study of the changes in the 'pellicle' absolutely demonstrate the fact that the visible new-born units of living matter behave in the manner which has been attributed to the invisible colloidal molecules. The living units combine, they undergo molecular re-arrangements; and the result of such a process of heterogenetic biocrasis is the appearance of larger and more complex organisms; just as the result of the combination and re-arrangement between the colloidal molecules was the appearance of primordial aggregates of living matter. Living matter is formed, therefore, after a process which is essentially similar to the mode by which higher organisms are derived from lower organisms in the pellicle on an organic infusion. All the steps in the latter process can be watched; it is one of synthesis—a merging of lower individualities into a higher individuality. And although such a process has been previously almost ignored in the world of living matter, it is no less real than when it takes place amongst the simpler elements of not-living matter. In both cases the phenomena are essentially dependent upon the 'properties' or 'inherent tendencies' of the matter which displays them."

Mathematical Society, March 14.—W. Spottiswoode, F.R.S., president, in the chair.—The President made a statement to the effect that it had been desirable to apply for a Charter, and that he had taken the requisite steps for ascertaining the right mode of procedure. The proposal made by the President being unanimously agreed to, the matter dropped.—A vote of thanks was passed to Mr. S. M. Drach for his present to the Society of two early and interesting works by Vieta and Ubaldi respectively.—The papers read were:—Prof. Clifford, "On a new expression of Invariants and Covariants by means of alternate numbers;" Hon. J. W. Strutt, "On the Vibrations of a gas contained within a rigid spherical cone." The former paper was concerned with methods given in "Vorlesungen über die complexen Zahlen und ihre Functionen," by Dr. Hermann Hankel (1867). In the latter paper the problem discussed was one referred to in a paper on the "Theory of Resonance," Phil. Trans., 1871. It is the only case of the vibration of air within a closed vessel which has hitherto been solved with complete generality. A result arrived at was that the pitch is about a fourth higher for the sphere than it is for a closed cylindrical pipe, whose length is equal the diameter of the sphere.—

Mr. A. J. Ellis, F.R.S., communicated a question which had been forwarded to him by Prof. Haldeman, of Columbia, Pennsylvania, U.S., "The number of lines in a rhymed stanza being given, how many variations of rhyme-distribution does it admit of, suppose no line to be left without a rhyme?"

Victoria Institute, March 18.—Mr. Charles Brooke, F.R.S., in the chair.—Dr. Bateman on "Darwinism tested by recent Researches as to the Localisation of the Faculty of Speech." Having called attention to Mr. Darwin's statement, that the difference between man and the higher animals was only one of degree, and not of kind, he proceeded to show that such could not be the fact, and instanced the faculty of articulate language, a distinctive attribute of which there was no trace in the ape or other animals. After defining articulate language, he demonstrated that it was exclusively man's prerogative, and there was no analogy between it and the forms of expression common to the lower animals. He then stated that it had been thought that a particular part of the brain was the seat of language, and, if it mere so, the Darwinian might contend that, as there was a certain similarity between the brain of man and of the ape and other animals, that they had the germs of the faculty. He then cited many cases which had been brought under the notice of German, French, American, English, and other surgeons, to show that even where various portions of the brain had been injured or destroyed, the faculty of speech remained He concluded by stating that the faculty of articulate speech seemed to be an attribute, the comprehension of which was at present beyond us.

GLASGOW

Geological Society, February 8.—Sir William Thomson, LL.D., was elected president; Messrs. E. A. Wünsch, John Young, and James Thomson, F.G.S., vice-presidents.—Professor Young, the retiring president, delivered an address on "Rock Formations in relation to Geological Time." He concluded by expressing the pleasure he felt in resigning the chair to one so eminent in the walks of science as Sir William Thomson, whose contributions to theoretical geology had been of the utmost importance.—The President, in taking the chair, briefly thanked the members for the honour they had conferred upon him, and hoped he might be of some service to them in the prosecution of geological inquiry.

DUBLIN

Natural History Society, March 6.—Professor E. Perceval Wright, president, in the chair.—The President delivered his inaugural address. He gave an interesting account of the history of the society from its commencement in 1838, when their meetings were held in Suffolk Street, and the opening address delivered by Mr. O'B. Bellingham. "There were then 104 members, and in 1840 the number had increased to 150. In 1844 the museum so increased that Mr. M'Coy was appointed curator, and he in 1845 laid a catalogue of the Irish animals in the museum before the society. This catalogue was printed and appended to the report for 1845-46. During these years many records of species new to Ireland were made. Very many valuable and interesting papers on zoological subjects were read. Many of these are to be found in full in the *Annals and Magazine of Natural History*. It is strange in looking over some of these to be reminded how great has been the development of some branches of natural science since they were written. Friends of many of us here—friends still living—many of them by no means yet full of days, yet wrote before the developmental stages of the crustacea were known, and could write of Spongilla as undoubtedly allied to the Diatomaceæ. About 1851 a few students in college, including myself, determined to form the University Natural Science Association, which is now amalgamated with the present society. Ere ceasing to speak of the College Society, let me pay a passing tribute to the memory of those who were our strong support, and who freely and generously held out to us that helping hand, and who have now left us for ever—Robert Ball, W. H. Harvey, A. H. Haliday, and A. Furlong; nor would it be seemly to forget all the encouragement and assistance given to us by the authorities of the College and the Regius Professor of Physic, or the loss we sustained when Allman, our Professor, counsellor, and friend was, by a hard fate, moved to succeed Forbes in Edinburgh."

PAMPHLETS RECEIVED.

ENGLISH.—The Dolmen Mounds and Amorpholithic Monuments of Brittany: S. P. Oliver, R.N. Remarks on the successive Mining Schools of Cornwall: J. H. Collins.—The Unity of Man's Being: A. Diesterweg.—Modern Examples of Road and Railway Bridges, Part I.: Maw and Dredge—Transactions of the Institution of Engineers and Shipbuilders in Scotland—Quarterly Weather Report of the Meteorological Office, July-Sept, 1870.—Annual Report of the Geologists' Association, 1871.—Modern Science and the Bible; their Positive and Direct Antagonism.—The Study of Economic Botany: Jas. Collins.—Lord Derby on the United Kingdom Alliance.—Statistics of the Liquor Traffic: Rev. D. Burns.—19th Report of the Executive Committee of the United Kingdom Alliance.—The Deviation of the Compass in Iron Ships: W. H. Rosser.—Proceedings of the Geologists' Association.—Report of the Committee on Ships of War.—Report of the Case of H.M.S. *Megæra*.—Journal of the Iron and Steel Institute, February.—Catalogue of Microscopical Preparations of the Quekett Microscopical Club.—On the Mechanical Impossibility of the Descent of Glaciers by their Weight only: Canon Moseley.—French Farmers' Seed Fund Reports.—Eastbourne Natural History Society Report.—Journal of the Royal Dublin Society, No. 40.—Quarterly Journal of the Meteorological Society.

AMERICAN & COLONIAL.—Hinrichs' School Laboratory of Physical Science, Nos. 3 and 4.—Experimental Steam Boiler Explosions: Prof Thurston.—Observations on Encke's Comet: Prof. C. A Young.—The Phœnix, for January, 1872.—Smithsonian Contributions to Knowledge; Converging series expressing the ratio between the diamater and circumference of a circle: W. Ferrel—7th Annual Catalogue of the Massachusetts Institute of Technology.—The Lens, No. 1.—Proceedings of the American Philosophical Society, July-Dec, 1871.—Lecture on Water: C. F. Chandler.—Inaugural Lecture of the Department of Practical Science in M'Gill University: G. F. Armstrong.—Lectures delivered at the Industrial and Technical Museum at Melbourne during the Autumn Session of 1871.

FOREIGN.—Bericht der Kaiserliche Akademie der Wissenschaften zu Wien.—Bulletin de l'Académie Impériale des Sciences de St Petersbourg.—Karte der Alpen in 8 ko orirten Blättern: Mayr u Berghaus.—Die Centralen Ortler-Alpen; nebst einem Anhange zu der Adamello-Presanella-Alpen: J. Payer.

DIARY

THURSDAY, APRIL 4.

LINNEAN SOCIETY, at 8.—On the Geographical Distribution of Compositæ: G. Bentham, President (concluded).
CHEMICAL SOCIETY, at 8.

FRIDAY, APRIL 5.

GEOLOGISTS' ASSOCIATION, at 8.—On the Excavations on the Site of the Law Courts: Wilfrid H. Hudleston, and F. G. H. Price.—On Columnar Basalts: John Curry.
ARCHÆOLOGICAL INSTITUTE, at 4.

MONDAY, APRIL 8.

ROYAL UNITED SERVICE INSTITUTION, at 8.30.—H.M S. *Agincourt* on, and off, the Pearl Rock: Commander R. H. Boyle, R.N.
ANTHROPOLOGICAL INSTITUTE, at 8. Notes on the Hair of Oceanic Races: Dr. B. Davis.—Note on the Hair of a Hindostanee: Dr. H. Blanc.—On the Descent of the Esquimaux: Dr. Rink.

TUESDAY, APRIL 9.

ROYAL INSTITUTION, at 3.—Statistics and Social Science: Dr. Guy.
PHOTOGRAPHIC SOCIETY, at 8.—M. Merget's Mercury Process.

WEDNESDAY, APRIL 10

GEOLOGICAL SOCIETY, at 8.—Notice of some of the Secondary Effects of the Earthquake of 10th January, 1869, in Cachar: Dr. Oldham, Calcutta, and Robert Mallet, F.R.S.—Notes on Atolls or Lagoon Islands: S. J. Whitnell. On the Glacial Phenomena of the Yorkshire Uplands: J. R. Dakyn.—Modern Glacial Action in Canada: Rev. W. Bleasdell, M.A.
SOCIETY OF ARTS, at 8.

THURSDAY, APRIL 11.

ROYAL SOCIETY, at 8 30.
SOCIETY OF ANTIQUARIES, at 8.30.
ROYAL INSTITUTION, at 3.—Heat and Light: Dr. Tyndall.
MATHEMATICAL SOCIETY, at 8.—On the Mechanical Description of certain Sextic Curves: Prof. Cayley, V.P., F.R.S.

CONTENTS

NOTICE

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