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THURSDAY, JULY 18, 1872

MEDICAL EDUCATION

A THOUGHTFUL address on "Medical Education in America," read by Dr. Bigelow to the Massachusetts Medical Society, has just been published in the form of a pamphlet. It discusses the important subject of the kind and degree of instruction in collateral sciences that should be given to the student of medicine during the short period of four years now at his disposal, and in the course of which he is supposed to have acquired the knowledge that will enable him to practise with advantage, or at least let us say with safety, to his patients, and with credit to himself. The question is of a very complex nature, and its difficulties can, perhaps, only be properly appreciated by those who have themselves been teachers, and who are not, therefore, likely to be led away by Utopian ideas of the amount of information that can be acquired by a man of ordinary abilities in this space of time even under favourable circumstances. It is very easy to say Educate to the highest point possible; let the student know something, at least, of Chemistry, of Botany, of Comparative Anatomy, of the origin, composition, and mode of manufacture of the drugs he uses; but the fact is overlooked that almost all he learns of these subjects is quickly cast aside when he begins to practise, because he finds that it is of no earthly use to him, and he regrets when too late the time he has spent in acquiring them, because it has led him to neglect the far more important matters of Pathological Anatomy, and the actual practice of Medicine and Surgery. "The Medical Student," Dr. Bigelow observes, "does not need to pick herbs from the field, or treat horses and dogs, or consider his parallelogram of forces before putting in a dislocated shoulder; but he does need to know how to recognise and exactly how to reduce a dislocated shoulder, how to recognise and treat human disease, and what are the medical properties of the drug which the farmer has grown, or the merchant imported for the apothecary. This is but a fair division of labour. He has enough to occupy him profitably and exclusively in his own immediate field of study, without wandering over the whole domain of knowledge—at least, at the mistaken behest of those who have a confused notion of a liberal education and large culture." "There is a fallacy in the idea of culture. Talent and power of application may, indeed, incidentally lead a man to eminence in several directions. But a cultivated, a literary, or even a scientific man is not necessarily the best physician." At the same time Dr. Bigelow concedes that there should be a certain latitude in the study of medical science on the ground that "no student or artisan is the worse for an outlook upon kindred arts and sciences which will help him to establish the true relations of his own, which will supply him with additional facilities and light for its pursuit, and with that training of his intellectual powers afforded by a systematic variation in their exercise." It must be remembered that all the sciences collateral to medicine have undergone extraordinary development during the past few years; and that to acquire a very moderate knowledge of chemistry, for example—such knowledge as would enable the student to analyse a single animal fluid, or even a fragment of a calculus—would be the undivided work of a year, and when accomplished he would scarcely be one step in advance of the man who had learnt a few rules of general application to the diagnosis of disease taught by an accomplished chemist.

Whilst agreeing with the general views expressed by Dr. Bigelow upon the education of the medical student as he now presents himself at the Hospital Schools at the age of eighteen or nineteen, it yet appears to us that the quality of the raw material, if we may call him so, might be immensely improved by the general adoption of a well-directed scheme of preliminary education. "One of the enormous follies of the enormously foolish education of England," said Sydney Smith, "is that all young men, dukes, fox-hunters, and merchants, are educated as if they were to keep a school or serve a curacy." Just so; and it is precisely in this respect that the education of the medical student of this country requires revision and improvement. The medical profession is not essentially a literary one. What is really required is a seeing eye and an understanding heart; the faculty of correct observation on the one hand, and on the other the ability to single out what is important amidst a multitude of unimportant particulars—in a word, judgment: and as this is capable of being immensely improved by exercise, it should surely be the point to which the education of the student should be directed. But, as a matter of fact, no line of education can be better adapted for the purpose in view than that of the medical student of the present day. From the beginning to the end it is or might be made a "questioning of nature." The grand defect of the system is that insufficient time is at the disposal of the student to master the details. He learns a little of many things; nothing well, unless it be his anatomy; but the advantage a knowledge of all would give him may be estimated in some remote degree by the value that teachers and students alike set upon this single acquisition. Seven years are not thought too long to make a master workman in any of the humblest trades; and yet the student is expected to acquire a fair knowledge of all the branches of a very wide, difficult, and profound intellectual pursuit in four short years, or if we read Dr. Bigelow aright, in three years in America. It is here we think, then, that some alteration is requisite. A boy who is going to enter the medical profession should be early set apart for that ministry. We are bold to say that a boy of fifteen knows or ought to know enough of Latin, Greek, and Arithmetic for any subsequent use he is likely to make of them. At this age he should be called upon to select what his future career shall be, and his education should be directed accordingly. From the inquiries of the Committee of Convocation of the University of London, *à propos* of the proposal for rendering the examination in Greek optional at Matriculation, it appears that there are several large schools of good repute in this country, as those of Cheltenham, Clifton, Haileybury, Marlborough, and Wellington, in which a "modern side" has been established, where attention is chiefly directed to the cultivation of mathematics and modern languages, Latin and Greek being considered as subsidiary branches of knowledge, or even completely omitted, as in the case of Greek at Cheltenham College.

We venture to suggest that in these, and, indeed, in every other large school in England, a third, or Natural Science department should be founded, in which Practical Chemistry, Field Botany, and Natural Philosophy, with the French and German languages, should form the subjects of study. We are confident that in the hands of competent teachers, a lad might obtain between the ages of fifteen and eighteen or nineteen, a very large amount of useful knowledge on these subjects, without any undue strain upon his intellectual powers; while we are convinced that such a scheme would prove successful in a pecuniary point of view; and that there would be ample funds, derived from the scholars in attendance, to pay the additional teachers that would be required. The instruction given need only be rudimentary; but it should be most precise and thoroughly acquired. Any chemist could select six elements, any botanist six natural orders, any zoologist six classes of animals, which, if thoroughly known, would constitute an invaluable training to the future physician. He would then enter the medical school with a well-cultivated mind accustomed to close observation, and prepared to profit to the utmost by the system of education now generally adopted.

ORNITHOLOGY OF NEW ZEALAND

Catalogue of the Birds of New Zealand, with Diagnosis of the Species. By Frederick Wollaston Hutton, F.G.S., Assistant Geologist. Published by Command. 8vo. (New Zealand, 1871.)

A History of the Birds of New Zealand. By Walter Lawry Buller, D.Sc., F.L.S., C.M.Z.S., &c. Part I. 8vo, coloured plates (London, 1872.)

BIRDS, as most people know, or ought to know, form the most important part of the vertebrate Fauna of New Zealand, and their importance is maintained not only when they are compared with their compatriots of other classes; but, when regarded in reference to members of their own class in the world at large, the birds of New Zealand offer so many singular forms that as a whole they deserve every consideration. Some of the most remarkable of these have already been mentioned by a distinguished writer in this periodical,* but perhaps hardly sufficient prominence was then given to the fact in the ornithology of New Zealand which seems of all others to demand attention; for, recent birds being divided into two great and trenchantly marked groups, of very unequal extent, the smaller of these groups (the *Ratitæ*) is found to contain six most natural sections, comprising, to take the most exaggerated estimate, less than two score of species, while the larger group (the *Carinatæ*), though perhaps not containing more natural sections, comprehends some ten thousand species. Now, two out of the six sections of this small group are absolutely restricted to New Zealand, and these two sections contain considerably more than half of the species known to belong to it. Thus, setting aside the Carinate birds of our distant dependency (and some of them are sufficiently wonderful), its recent Ratite forms—some twenty species, let us say—alone may be regarded as the proportional equivalent of one-tenth of the birds of the globe, or numerically, we may say, of an avifauna of about one thousand species.

* NATURE, June 23, 1870, and Jan. 5, 1871.

The birds of New Zealand, therefore, merit especial attention, and we are happy to say they receive it at the hands of the authors whose works are above cited. Taking the field in or about the year 1865, Mr. Buller, till then unknown to fame beyond the limits of his native colony, brought out an "Essay on the Ornithology of New Zealand," which at once attracted notice in this old world of ours. Some of his views were challenged by Dr. Finsch, then of Leyden, who had paid attention to this extraordinary avifauna, and a controversy ensued. This, to the credit of the controversialists, was carried on in a spirit very different from that in which many another war in natural-history circles has been waged, and the happy result is that on most points the combatants have arrived at the same conclusion, thereby giving assurance to the general public of its being the right one. The Essay we have mentioned may be regarded as the preliminary canter which a race-horse takes before he puts forth his full strength; and Mr. Buller's book, or that part of it which is as yet published, shows what he can do now that the colonial authorities have allowed him to come to England for the express purpose of completing his design.

Captain Hutton is known as an observer who, during several long voyages, had proved that some rational occupation could be found at sea even by a landsman; for, instead of devoting his energies to the ordinary time-killing amusements of shipboard, he watched the flight of the various oceanic birds which presented themselves, and speculated on the mode in which it was performed and the forces it brought into operation—to some purpose as the Duke of Argyll and Dr. Pettigrew have testified. The pamphlet whose title we give is in some respects a not less significant, if a less ambitious, work than Mr. Buller's; and though to the last must belong the crown of glory, we by no means wish to overlook the useful part which Captain Hutton's publication will play. If here we do not notice it further, it is because its value will be most appreciated in the colony itself, while Mr. Buller's beautiful book appeals to a larger public.

Of the baker's dozen of species included in this first part of the "History of the Birds of New Zealand," we propose to notice only those belonging to three genera, two of them quite peculiar to the country, while the third is, or was, found in the neighbouring islands of the same zoo-geographical province. The remaining eight species belong to types of far wider distribution; hawks, owls, and kingfishers present much the same features all the world over, and the New Zealand parrakeets do not much differ from their congeners which are found in other portions of the Australian region.

The Kakapo, or Owl-parrot (*Strigops habroptilus*), is without doubt one of the most remarkable of New Zealand birds. It has already been figured in these columns;* but perhaps a few more words about it may not come amiss. Its crepuscular habits seem to have kept it hidden from the earlier explorers, and it was not until 1845 that this singular form was made known to naturalists by the late Mr. Gray. Possessing ample wings, it disdains their use; and to such an extent has this desuetude reached that its osteology is thereby materially affected, and it stands alone among Carinate birds as having the keel of its breast-bone dwarfed into a mere ridge, such as is

* NATURE, Jan. 5, 1871.

familiar to the anatomist as the attachment of an ordinary muscle, instead of the highly developed crest common to every other known Parrot. Prof. Huxley has even suggested a doubt whether its sternum is ossified as in other *Carinatæ;* but this seems an excess of caution on his part, though we must admit that, until an investigator such as Mr. Parker has had the opportunity of examining an embryo, the question cannot be decided.

Of the Kakas (*Nestor*) Mr. Buller admits three species —*Nestor meridionalis*, *N. occidentalis*, and *N. notabilis*— the two first of which, we think, are barely separable. This very remarkable genus of Parrots includes some two or three other species, one of which, the *N. productus* of Phillip Island, is believed to have gone the way of so many animals that only inhabit small islands, and the same fate in all likelihood awaits its congeners. Most animals suffer from not being able to accommodate themselves to change of circumstances, but the very adaptability of the Mountain-Kaka, or Kea, will tend to its early destruction; for, though belonging to the groups of Parrots distinguished by their brush-like tongue, and deriving a considerable portion of their subsistence in a manner worthy of the Golden Age from the nectar of flowers, this wretched Kea (*N. notabilis*), since the introduction of sheep to New Zealand, has incurred the imputation of a fondness for mutton-cutlets *à l'Abyssinie**, and the charge, whether true or false, is likely to bring about its doom, since the shepherd is apt to practise what in good old times was called "border justice," and the species will probably suffer extinction before its guilt is fully proved or extenuating circumstances admitted. The Common Kaka (*N. meridionalis*), on the other hand, is ably defended by Mr. Buller as one of the most useful birds in the country; yet this also is rapidly diminishing. "In some districts," he says, "where in former years they were excessively abundant, their cry is now seldom or never heard," and though he adds that "in the wooded parts of the interior they are as plentiful as ever," it requires no prophetic eye to see that, with the extension of settlements, the Kaka must succumb.

The last bird we can especially mention is the Huia (*Heteralocha acutirostris*), known to our readers by a woodcut in these columns.† Mr. Buller, we must remark, has unhappily referred it to the Hoopoes (*Upupidæ*) with which, so far as we can see, it has nothing in common. Mr. Garrod has lately informed the Zoological Society that it belongs to the Starlings (*Sturnidæ*), and there can be little doubt that he is right in doing so; but it seems also to have some affinity to the Crows; and it is worthy of remark that one of its chief peculiarities, the diversity of the bill according to sex, is shared to some extent with an aberrant corvine form (*Nucifraga caryocatactes*). A distinguished zoologist has said that "such a divergence in the beak of the two sexes is very uncommon, and scarcely to be paralleled in the class of birds. It is difficult to guess at the reason of this, or to explain it on Darwinian or any other principles." Now, to us the difficulty does not seem greater than that presented by any other sexual characteristic, and on Darwinian principles the explanation is easy enough, if once the utility of the difference is established. This last is well shown by Mr. Buller's remarks on a pair of caged Huias which he kept for more than a year, and his account justifies the belief that had previously been entertained about them:—

"But what interested me most of all was the manner in which the birds assisted each other in their search for food, because it appeared to explain the use, in the economy of nature, of the differently formed bills in the two sexes. To divert the birds, I introduced a log of decayed wood infected with the huhu grub. They at once attacked it, carefully probing the softer parts with their bills, and then vigorously assailing them, scooping out the decayed wood till the larva or pupa was visible, when it was carefully drawn from its cell, treated in the way described above, and then swallowed. The very different development of the mandibles in the two sexes enabled them to perform separate offices. The male always attacked the more decayed portions of the wood, chiselling out his prey after the manner of some Woodpeckers, while the female probed with her long pliant bill the other cells, where the hardness of the surrounding parts resisted the chisel of her mate. Sometimes I observed the male remove the decayed portion without being able to reach the grub, when the female would at once come to his aid, and accomplish with her slender bill what he had failed to do. I noticed, however, that the female always appropriated to her own use the morsels thus obtained."

Here we must pause. Mr. Buller's book is in every way worthy of its subject, and we trust that we have shown that the subject is worthy of close attention—whether we regard the various forms of New Zealand birds from the point of view of their intrinsic interest, or from that of so many being now on the verge of extinction. It is easy to be wise after the event, and ornithologists at home do not in these days look back affectionately towards their predecessors who have let so many species pass away without tracing the process of extermination. We have above hinted at some of the causes of extinction which seem to be at work; and most of them, it is to be feared, are insuperable: but there is another, and possibly more powerful cause which is entirely under control. This is the silly mania for "acclimatisation" which has been so warmly fostered by many well-meaning though ill-advised persons, both at home and in the colonies, and nowhere more than in New Zealand. The English Acclimatisation Society fortunately came to an end, and before it had time to do any harm here; but its example has been mischievous in our dependencies. In a reckless way animals of extremely doubtful advantage have been transported to the antipodes, and there it seems impossible to deny that they will in a few years be found not only ousting the kinds which are less specialised, and therefore less able to meet them on an equal footing; but, unaccompanied by any of those checks which keep the whole of a natural fauna balanced, the importations will inevitably become the greatest of nuisances. The memory of the patriotic Scot who could not live without his thistles is not exactly blessed by Australians, and among the pilgrim fathers of New Zealand who will ultimately obtain an apotheosis, the members of their various acclimatisation societies will, we suspect, scarcely be reckoned.

* NATURE, Oct. 19, 1871, and Feb. 1, 1872.
† NATURE, June 23, 1870.

OUR BOOK SHELF

The Messenger of Mathematics. New series. Edited by Messrs. Whitworth, Taylor, Lewis, Pendlebury, and Glaisher. Vol. i. (Macmillan and Co., London, 1872.)

THE twelfth monthly number of the new series of the "Messenger of Mathematics" has just been published. This offers a convenient epoch for estimating the aims and achievements of this new mathematical periodical.

The principal aim of the editors was stated in their introductory note to be the fostering of a continuous and ample supply of original investigations into the more and more specialised branches of mathematics. This originality was to be welcomed from whatever quarter it came—whether from mathematicians of established reputation or from junior students of the science; whether from the Universities of this country or from more distant centres.

The intentions of the editors have been fully realised by the publication of the twelve numbers now before us. The list of the contributors to these numbers contains nearly twice as many names as there are numbers of the magazine. And while in that list we find the names of some of the foremost mathematicians of the age, such as Messrs. Cayley, Routh, Stokes, and Townsend, we find also a considerably greater number of the names of junior students, some of whom have only recently graduated. The localities of the contributors are also as various as was intended, one of them, for example, writing from Queensland.

As regards the articles themselves, there are about four times as many on pure mathematics as there are on applied mathematics. Among the former we find, for example, such a simple matter as a very elegant proof, by Mr. Taylor, of Euclid, ii. 8, in which he makes a further step towards the elimination of the diagonals from the diagrams of the Second Book of Euclid. This construction is recommended to the attention of the Association for the Improvement of Geometrical Teaching. We find also such interesting contributions to the study of the higher geometry as Prof. Cayley's articles on the "Theory of Envelopes," and on "Penultimate Quartics;" Mr. Merrifield's article on "Families of Surfaces;" and Mr. Townsend's on "Confocal Quadrics." The articles on other branches of pure mathematics are as varied and as instructive as those on geometry. There is, for example, a spirited controversy between Prof. Cayley and Mr. Wilkinson, about the quantitative limitations which have, in more recent times, been imposed on the generality of Taylor's theorem. Prof. Cayley's plea for greater liberty of interpretation, and against confining our symbols in mathematics so exclusively to quantity, is especially effective and well-timed; for the more liberal our interpretations the vaster will be the domains we can overrun and occupy by means of our symbols, and the greater will be the tendency to that specialisation of efforts, or division of labour, which is so characteristic of modern mathematical research, and which the publication before us aims to combine by co-operation. Then there are "Exercises on the Integral Calculus," by Sir John Cockle, and papers on "Definite Integrals," by Glaisher; besides articles treating of many other subjects, too numerous to mention.

Among the articles on applied mathematics we find one by Prof. Stokes, on the "Compound Pendulum;" two by Mr. Routh, on the "Oscillations of a Heavy String," and an improved solution of a problem in the Astronomer Royal's "Undulatory Theory of Optics;" one by M. Leclert, on "Naval Geometry;" two by Mr. Hopkinson, on "Electricity;" and so on. There is also a most elegant model of mathematical style, especially suitable for intending competitors in mathematical examinations, namely, the solutions, by Prof. Cayley, of the whole of a Smith's Prize Paper, which are of the stiffest ever set.

With all its variety of contents, this magazine is still eminently readable, principally on account of an utter absence of that tendency to riot in new terminology, or scientific slang, which disfigures the pages of some modern mathematical writers. The typography is also very good.

We shall be well satisfied if vol. ii. maintains the high standard set by vol. i.; but we should be pleased to find in it a little larger proportion of articles on applied mathematics. There is much interest felt at present in such subjects as molecular mathematics; the theory of electricity and magnetism; the determination of the centres of gravity of ships; and such like problems in advanced theory or in complicated practice. We should be glad to see the miscellaneous portion of the magazine, containing notices and reports of the meetings of mathematical societies, reviews of books, &c., somewhat extended, even if the present very moderate charge of a shilling a number was somewhat exceeded in consequence. There has been, for example, no notice of the large and influential meeting held last January by the Association for the Improvement of Geometrical Teaching. Now, in that association the want of a monthly organ is much deplored. Why should not the "Messenger" fill that void? Perhaps, also, if the size of the "Messenger" were increased, space might be found for queries and notes from correspondents; and the name might be advantageously altered to "The Mathematical Magazine." But, in any case, every student who wishes to keep abreast of the current of contemporary mathematical thought should subscribe to this excellent little periodical.

LETTERS TO THE EDITOR

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

Spectrum of Lightning

ON the 11th inst. there was a considerable thunderstorm in Patterdale, and I was again able to observe the lightning spectrum. Among other lines I saw one repeatedly near D_1 and about the centre of the bright yellow band between the two masses of atmospheric absorption lines in that neighbourhood. I also saw the line near *b*. Both correspond in position with principal air-lines.

But besides this line spectrum I repeatedly saw a continuous spectrum with bright bands, which might have been the low temperature nitrogen spectrum, though I feel no certainty that such was the case. There seems, however, no doubt that lightning gives two different spectra, one of bright lines, and the other continuous; unless indeed the latter be identical with the former, but with the lines much expanded. I do not think this is the case.

HENRY R. PROCTER

P.S.—Since writing the above there has been another thunderstorm, during which I more distinctly saw the band spectrum. I find that it is not the ordinary nitrogen band spectrum, but might be a very much expanded line spectrum. It is however difficult to understand the cause of so great a difference, for the line spectrum was very sharp and well defined. I thought I was able to recognise that the latter corresponded to the shorter and sharper peals of thunder. The spectrum showed no connection with the brilliancy of the flash. I recollect that in a brilliant thunderstorm which I lately witnessed at night in Syria, some flashes lighted up the dull foliage of the prickly pear to a vivid green; while others, showing the form of the landscape with nearly equal distinctness, left it almost colourless. I had then, unfortunately, no spectroscope.

Patterdale, Penrith, July 12

Aurora of July 7

THE very fine aurora of Sunday night, July 7, was well seen near Leenane, on Killary Harbour (lat. 53° 36′, long. 9° 45′, nearly), in the west of Ireland. Probably this is the most westerly station in Europe from which the phenomenon has been observed with some approach to accuracy; and if the centre of the corona be, as it seems to be (*pace* some of your correspondents), an actual, substantive point, and not merely the effect of perspective, the following observations may help in determining its height above the earth. At 11.0 exactly, Greenwich time, the centre of the very well developed corona had an altitude of 68°, with an azimuth bearing of 21° E. of S., a little W. of magnetic S. (these measurements being taken as correctly as could be done with a good-sized compass furnished with a clinometer), and it was distant from α Lyræ (*Vega*) about 8° towards S.W.; this distance being afterwards diminished by the rotation of the earth. The aurora was observed independently by Messrs. Kinahan and Symes, of the Irish Geological Survey, in the same neighbourhood, and they also noted the proximity of the centre to the above-mentioned star. I do not trouble you with other details. M. H. CLOSE

Newtown Park, Black Rock, Dublin, July 13

I WITNESSED last night what must have been a somewhat brilliant display of aurora. From 10.45 P.M. to 11.0 P.M. slight breaks in the N.E. were brightly lit up with a rosy glare, and another break in the N. with the green rays. Coruscations of light flashed up from time to time, and were visible even through the clouds, which consisted of somewhat dense nimbus. The display in a clearer sky must have been decidedly fine.

Bridport, Dorset, July 8 J. EDMUND CLARKE

Registering Thermometer

MR. WHIPPLE and Mr. Bushell have shown great ingenuity in suggesting remedies for the copious condensation of moisture which takes place in the interior of the jackets of minimum thermometers on the grass.

Both their suggestions I have found fail to work a permanent cure; the chloride of calcium (only of use when the stopping is perfect) soon becomes super-saturated, and itself gives off moisture. The putty and sealing-wax hold good for about five or six months, and then the insidious moisture permeates again. Would it not be better to adopt my very simple plan of discarding the jacket altogether? It is absolutely useless, and no stopping is really effectual in resisting for long the daily extremes of heat and cold and damp and dryness these thermometers must undergo.

I have used a thermometer on the grass for the last three years entirely unmounted, and find its indications in no way effected by the loss of its outer coat.

CHARLES H. GRIFFITH

The Rectory, Stratfield Turgiss, Winchfield, Hants, July 5

Luminous Matter in the Atmosphere

I WAS much interested by M. Waldner's short article on "Luminous Matter in the Atmosphere" in the number of NATURE for Feb. 15, 1872. Being unable to see the particles described, I applied to him for further directions, and he was kind enough to inform me that they may be seen *à vision directe* with a telescope.

I have since found that many of the little bodies may be seen with the naked eye by shutting out the powerful direct and lateral rays. This may be done, *e.g.*, by partly closing the *jalousies* or outside shutters used here, and then looking for the particles at about the distance of quarter of a degree, or of the sun's radius from the border of his disc, when the sun is either just below the upper edge of the shutter, or immediately above the ledge of the house if it looks east and west. Shutters are not always necessary. I have just seen great numbers by standing on the border of the shadow thrown by the adjoining house. Even by holding my hat over my head I can perceive some of them. The chief object to be aimed at is to prevent the eyes from being dazzled by the direct rays of the sun. The same principle explains the reason why stars are sometimes seen during the day from the bottom of a well or through a telescope, and why the red protuberances of the sun become visible during an ordinary or artificial eclipse.

On the 9th and 10th current, and again this morning, there was a haziness round the sun, which gradually diminished as the angular distance from his disc increased, until the sky became beautifully blue at an angle of 25° or 30°. I found that the haziness was produced by the reflection of the sunbeams from innumerable little particles. Many of them were distinctly visible to the naked eye, but many more were seen with an opera-glass or telescope. They passed too rapidly to be counted, but fifty at least were in the field of my glass at one time. I am sure that this is no optical delusion, for several of my friends have seen them too.

What were these little particles? M. Waldner supposes them to be crystals of ice, and they certainly look like miniature snowstorms. Perhaps some of your readers may be able to decide whether the higher particles are composed of ice-like cirri, the loftiest of the clouds. But some of the corpuscles of the lower strata of the air are undoubtedly seeds, little organic substances, insects, &c. I have caught several feathery little seeds of this kind. They are almost imperceptible when seen against some white substance, and are so light that the slightest currents of air waft them to great distances.

Another instance of numberless little vegetable substances being blown here may be cited, namely, the pollen of the pine trees growing on the Landes. An unusually large quantity of this fell here on April 17, 18, 19, and 20, and may probably be traced to three extensive fires of pine woods sixty or eighty miles N.W. of Pau (April 14-16). The pollen was doubtless drawn upwards by a strong current of heated air, and then wafted to Pau by the wind, which blew in the right direction (April 17-19). The wind changed at Bordeaux on the 20th, and the pollen then fell (April 21-22) near Perigueux, nearly as far to the N.E. of the fires as Pau is to the S.E. A correspondent of the *Times* (April 30), mistaking the pollen for sulphur, announced that a shower of this substance had fallen here, and supposed that it was connected with the eruption of Vesuvius, which, however, did not begin until the 24th.

I would suggest that some record should be kept of the direction of the wind which these particles indicate in different strata of the atmosphere in fine weather. J. F. ANDERSON

4, Place Duplace, Pau, June 12

Vibration of Glasses containing Effervescing Liquids

IT is known that a glass containing effervescing liquid will not give a clear note when struck, and that as the effervescence subsides the tone becomes more and more clear. When the liquid is perfectly tranquil the glass will ring as usual, but on re-exciting the effervescence the musical tone again disappears. Sir John Herschel (Encyc. Met., Art. "Sound"), who states that this experiment appears to have been originally made by Chladin, quotes it as an "example of the stifling and obstruction of the pulses propagated through a medium, from the effect of its non-homogeneity;" and, in explanation of the phenomena, he says:—"We must consider what passes in the communication of vibrations through the liquid from one side of the glass to the other. The glass and contained liquid, to give a musical tone, must vibrate regularly in unison as a system; and it is clear, that if any considerable part of a system be unsusceptible of regular vibration, the whole must be so."

The phenomenon, then, according to this explanation, is due to the fact that the liquid, during effervescence, becomes non-homogeneous, and thus obstructs the passage of the sonorous vibrations from one side of the glass to the other.

It is with much diffidence that I venture to express dissent from so eminent an authority as Herschel; but it does not appear to me that the above explanation is entirely satisfactory, for the following reasons:—

1. It seems probable that the sonorous vibrations pass *round* the glass rather than *across* it. For, if they pass across the glass, that will occur whether it contains water or air. Yet the musical tone of a glass containing air is not destroyed by suspending within it, so as not to touch it, a ball or cylinder of wool or cotton, although the sonorous vibrations certainly cannot pass freely through that substance.

2. If the non-homogeneity of the contained liquid be the cause why the sonorous vibrations will not pass, whence comes it that treacle, clear honey, &c., which are homogeneous fluids, destroy the musical ring of a glass fully filled with any of them?

The phenomenon presents itself to my mind as being due to a certain amount of vibration communicated to the glass by the agitation arising from the effervescence. This vibration—which can be easily heard by placing the ear close to the glass—interferes with that caused by striking the glass, and destroys more or less the proper rhythmic movement necessary to the production of a musical note, according as the intensity of the agitation of effervescence is greater or less.

The dead sound of a cracked glass is probably owing to a similar cause. For in that case, as soon as the vibrations travelling round the glass arrive at the crack, the edges of which are wholly or partially in contact, they are transmitted from edge to edge, and as, owing to the friction of the edges one against the other, their vibrations do not synchronise, a reflex wave is impinged upon each, having a less velocity than the original wave. This reflex wave will correspond to the vibrations caused by effervescence. If the crack be cleanly cut out, so as to separate the edges by a well-defined interval, the glass will again emit a musical note. In the latter case, the sonorous vibrations, on arriving at the cut portion, return by the way they came, synchronising with those which they meet.

The dead sound of the glass, when filled with honey or treacle, is probably owing to the circumstance of these fluids being not sufficiently mobile to vibrate in unison with the glass; and thus they destroy its musical tone as effectually as if they generated an independent and non-synchronous vibration.

London, July 4 ALLEN BEAZELEY

The Names Cambrian and Silurian in Geology

WILL you allow me to express, as an humble worker among the rocks of North Wales, my sense of the high value of the contributions to your pages recently by Prof. Sterry Hunt on the "History of the names Cambrian and Silurian in Geology?" I have long felt—and have not hesitated to express my feeling—that a great wrong was done to Prof. Sedgwick when the North Wales groups of rocks from the Bala Beds to the Lingula Flags—the order of which he was the first to unravel in that difficult region—were unceremoniously engulphed in Siluria.

It has also appeared to me one of the greatest anomalies in English geological classification, that the magnificent and well-defined groups of North Wales should be typified by their attenuated and broken easterly outcrops in the Silurian district of South Shropshire. What Llandeilo section of Siluria is there that worthily represents the Arenig and lower Bala rocks immediately east or west of the Berwyn Mountains? What Caradoc section of Siluria is there at all worthy of the fine series of the Upper Bala rocks of Glyn Ceiriog? Of the unworthiness of the schists near the Stiper stones to represent the Lingula beds of North Wales, Prof. Hunt justly speaks in his papers.

I am glad that justice seems at last likely to be done to the veteran, Prof. Sedgwick, than whom a more philosophical geololist I am persuaded does not exist. Let but a sufficient number of scientific men resolve to use his older and truer, because more natural classification, and the justice will soon be complete.

D. C. DAVIES

ON THE VARIATION OF SPECIES AS RELATED TO THEIR GEOGRAPHICAL DISTRIBUTION, ILLUSTRATED BY THE ACHATINELLINÆ

IT has long been known that island species are usually different from, but allied to, those of the neighbouring continents. Darwin has also made us familiar with the fact that each of the Galapagos Islands has a fauna, and to some extent a flora, of its own. Other explorers have called attention to the somewhat limited distribution of species in the West Indies and on other islands. I have been informed by Mr. T. Bland, who has given special attention to the terrestrial molluscs of the West Indies, that if Cuba should be divided into two islands by the submerging of the central portion, about half of the species on either of these islands would be different from those on the other. Some of the most remarkable facts of this kind appear in the distribution of the Achatinellinæ on the Sandwich Islands. As they have never been fully recorded, I make the following brief statement of the leading facts, gathered from the results of personal exploration, and suggest a few inquiries.

Many types of the Sandwich Island Helicidæ have at different times been classed under the generic name of *Achatinella*. These widely differing forms have, in the structure of the shell, one point of correspondence that holds them together. The columella has a spiral twist which is more or less apparent in all. In most of the species this character is so strongly developed that the columella seems to be armed with a lamellated tooth revolving within the shell. This common characteristic, in connection with the fact that they are all confined within the limits of one small geographical area, affords sufficient reason for regarding even the most divergent of these types as belonging to one group. As the humming birds are peculiar to America, so the Achatinellinæ are peculiar to the Sandwich Islands.

Though the forms thus brought together evidently constitute a natural group, it has long been apparent that they should be classed under more than one generic name. Some of these genera are restricted to one or two islands.

Genera on Kauai

Several large turreted species of a peculiar type, found only on the island of Kauai, had been provided for at different times under the names of *Achatina*, *Achatinella*, and *Spiraxis*; but no resting-place was found for them till shelter was provided under the separate name of *Carelia*, given by H. and A. Adams. *Carelia turricula*, a species which is sometimes three inches in length and about an inch in diameter, may stand as the representative of this genus. Besides the six or eight species of *Carelia* which have been described, there are many other species of land shells peculiar to this island, the most northern and western of the group. Some of these are *Helices*; the others belong to *Amastra* (H. and A. Adams) and *Leptachatina* (Gould), two genera which are also represented on the other islands of the group. None of the species of this island present any of the brilliant colours that are so common in the shells of Oahu. The peculiar forms of some of the species, as of *Amastra Kauaiensis* and *Carelia cumingiana*, as well as the relations of these aberrant types to the types found on the other islands, render them objects of great interest.

Genera on Oahu

On the island of Oahu, which lies next to Kauai on the south-east, we find a remarkable development of the Helicidæ. The ground species belong to the two genera just mentioned, *Amastra* and *Leptachatina*. *A. ventulus* is an example of the former, and *L. vitrea* of the latter. Over twenty-five species of each have been found on this island. Two arboreal genera—the *Bulimella* (Pfeiffer) and *Helicterella* (Gulick)—are found only on this island. The ellipsoidal form, as in *B. rosea*, characterises the former; and the conical form, as in *H. apiculata*, the latter. Of *Bulimella* there are about thirty known species; of *Helicterella* thirty-five. The different species of *Bulimella* present a great variety of colours, ranging from bright green and rose, through yellow, brown, and ash, to simple black and white. The prevailing colours of the *Helicterella* are white, black, and brown, variously arranged in bands and stripes. The arboreal genus *Achatinella* (Swainson) may also be regarded as belonging especially to Oahu, as it is here represented by fifty-four species, and elsewhere by but three, which are found only on the island of Molokai, about fifteen miles to the east. *Achatinella producta*, about one inch in length, is one of the largest of the family. The *Auriculella* (Pfeiffer) is a genus of small arboreal species found on Oahu, and also on the islands to the east. Many of them are unnamed; but those on Oahu probably number more than ten. *Auriculella auricula* is given by Pfeiffer as the type. Two other arboreal genera—*Partulina* (Pfeiffer) and *Laminella* (Pfeiffer)—which find their chief development on the islands of Maui, Molokai, and Lanai, are represented on this island by three species each. The types, as given by Pfeiffer, are *Partulina virgulata*, found on Molokai, and *Laminella gravida*, on Oahu.

Number of Species and Varieties on Oahu, and the Regions they Inhabit

The number of species of Achatinellinæ on Oahu may be estimated at about 185, representing eight genera, but belonging chiefly to five. Besides these there are many small *Helices*, which would probably bring the whole number of the species of Helicidæ on Oahu up to about 200, the varieties numbering 800 or 900. None of these species—excepting, perhaps, one or two of the ground species, which are reported to have been found on the island of Maui—exist anywhere beyond the narrow circuit of this island, the extreme length of which is only 60 miles, with an average breadth of about 15 miles. Nor does any one species occupy a large proportion of even this area. Nearly all are confined to the forest regions skirting two ranges of mountains. The chief range, on the north-east side of the island, is about 40 miles in length. The forest region that covers it has an average breadth of five or six miles. The range on the opposite side of the island is about half as long, and has only about one-fourth as much forest land. The north-eastern side of the island, owing to its receiving the trade-winds when they first strike the island, enjoys a moister climate and possesses more luxuriant vegetation than the south-western side. We are therefore somewhat prepared to find that seven-eighths of the species, or about 175, are found in the former area, about 40 miles in length and five or six miles in width. Passing over innumerable minor variations, the varieties found in this area are no less than 700 or 800.

That so large a number of species and varieties of land molluscs should be found within so small an area is, I think, unparalleled in the records of conchology; but that this great number of forms should, with but two or three exceptions, be found nowhere beyond these narrow limits, not even on the other half of the same island, is still more astonishing. What shall we say when we discover that no one of these species is distributed over even half of this small mountain range; but that in most cases they are restricted to areas of from one to five miles in length? Have we found one of the "centres of creation"?

The principal facts in the geographical distribution of these forms are as follows:—

I.—*Facts relating to the Position and Natural Divisions of the Territory*

The Sandwich Islands are surrounded by a wider expanse of open ocean than any other islands of equal extent. The forms of Helicidæ on this group differ widely from those of other lands. Not only do we find distinct species and genera, but a separate group of genera.

The group of islands may be divided into four provinces, each of which has a separate set of species and possesses one genus or more that is peculiar to the province, besides other genera that are common to several provinces. (*a*) On Kauai alone is found the *Carelia*; (*b*) on Oahu, the *Bulimella* and *Helicterella*; (*c*) on Maui, Molokai and Lanai, the *Newcombia* (Pfeiffer); (*d*) on Hawaii, certain peculiar forms that have not yet been fully collected or classified. Kauai, which is separated from the other islands by the widest channel, has the forms that differ the most widely from those of the central part of the group.

Most of the species are confined to the forests of mountain regions; and where, as on Oahu and Maui, there are two regions of forest divided by several miles of grass country, the island is also divided into two sections, having but few, if any, species in common.

On the island of Oahu, the two sections which occupy separate mountain ranges are divided into many minor sections in the following manner. From each side of the main range project mountain ridges, which separate deep valleys a mile or two in width. Each of these valleys is a subordinate section, having its own varieties and in many instances its own species, which are found nowhere else.

II.—*Facts relating to the Variation and Affinity of Species*

Nearly all the species of one genus found on one mountain range are connected by varieties presenting very minute gradations of form and colour. Species of the same genus on different islands are not so completely connected by intermediate forms.

The degree of difference between several species of the same group is in proportion to their separation in space.

Nearly allied species, occupying neighbouring localities, pass into each other by all the intermediate gradations of form and colour, while those whose homes are separated by a distance of eight or ten miles, cannot be connected by minute gradations without bringing in some of the forms occupying the intermediate territory.

As the relations to each other of the valleys surrounding any mountain are determined by the shape of the mountain with its ridges, so are the relations of these species to each other, in the arrangement of their affinities and divergences, influenced by the same cause. As the geometrical relations to each other of valleys clustered around one central peak differ from those distributed on either side of a long range, so do the affinities and divergences (the structural relations to each other) of the species on one of the high solitary mountains of Maui differ from those on one of the mountain ranges of Oahu. On the eastern range of Oahu the species of *Achatinella* are distributed on both sides of the mountain in parallel lines, the extremes of divergence being in the forms at the ends of the range. But either on East Maui or West Maui, where the arrangement of the valleys is more concentric, the varieties of any one group of species converge so rapidly toward one central type, that it is difficult to distribute them into well-defined species.

III.—*Facts relating to the comparative Area occupied by Species of different Classes*

The average length of the area occupied by different species is perhaps five miles.

Field species have the widest range. Arboreal species have the narrowest range. Ground species found in forest regions have a medium range.

Many interesting questions are suggested by these facts. How can we account for the species being restricted in their distribution to such narrow limits? Why do not the species of North-eastern Oahu pass over their narrow bounds and become mingled throughout the whole extent of that short mountain range?

Questions Suggested

The minute gradations by which the species of each genus of the Achatinellinæ are connected with each other strongly favours the belief that many of them must have been derived the one from the other by successive variations. If created independently, why should there be such gradation? Why should the species of one group be so arranged that those intermediate in form are found in intermediate localities? It may be said that those of one group, which are gradated together by intermediate varieties, are not only from one stock, but are one species. If they are one species, how shall we account for the difference of size and form, the entire change of colour, and in many instances of habits, leading some of the so-called varieties to avoid plants that are chosen by other varieties living only a few miles distant, and to choose plants that are rejected by the others? Why should the *Achatinellæ* feed on Kukui trees (*Aleurites triloba*) in the eastern districts of the island, and in the north-western choose small shrubs, leaving the Kukui trees to the *Bulimellæ*? Whether we call the different forms species or varieties, the same questions are suggested, as to how they have arisen, and how they have been distributed in their several localities.

In attempting to answer these questions, we find it difficult to point to any of those active causes of accumulated variation, classed by Darwin as illustrations of

"Natural Selection." The conditions under which they live are so completely similar, that it does not appear what ground there can be for difference in the characters best fitting the possessors for survival in the different valleys in which they are found. The vegetation is much the same; the bird and insect enemies, so far as they have any, are the same. The north-east side of the mountain range is a little more rainy than the opposite side, but this does not account for the different forms found in the successive valleys on the same side of the range. In what respect can the conditions of survival to which *Achatinella Stewarti* is subjected in Manoa, differ from those under which *A. producta* lives in Makiki, only a mile distant, or from those in which *A. varia* is placed in Palolo, three miles away? There is no reason to doubt that some varieties less fitted to survive have disappeared; but it does not follow that the "Survival of the Fittest"—(those best fitted when compared with those dying prematurely, but equally fitted when compared with each other)—is the determining cause which has led to these three species being separated from each other in adjoining valleys. The "Survival of the Fittest" still leaves a problem concerning the distribution of those equally fitted. It cannot be shown that the "Survival of the Fittest" is at variance with the survival, under one set of external circumstances, of varieties differing more and more widely from each other in each successive generation. The case of the three species under consideration does not seem to be one in which difference of "Environment" has been the occasion of different forms preserved in the different localities. It is rather one in which varieties resulting from some other cause, though equally fitted to survive in each of the three localities, have been distributed according to their affinities in separate localities. There is no reason to think that *A. producta* is not as well fitted to live on the Kukui trees that abound in Manoa and Pololo, as on the same trees in Makiki. Again, is the "Survival of the Fittest" sufficient to explain their being kept within these extremely narrow limits since they were produced? One would at first suppose that, in the course of a few years, or in a few hundred years at the farthest, the three species would have been diffused throughout this area of only five or six square miles which is now divided between them.

We seek in vain for an explanation of these facts in the still further principle of variation, set forth by Herbert Spencer under the effects of change in use, and discussed by Prof. Cope under the names of "Acceleration and Retardation." This cause of accelerated variation has influence only where there is a difference in the "use, either compulsory or optional." If, on the one hand, the change is compulsory, it must be owing to a change in external circumstances. But in the case of these three species we are unable to find any difference in their circumstances requiring change. Their enemies are the same, the climate is the same, and they undoubtedly eat the same food, for the chief resort of all is the Kukui tree. If, on the other hand, the change in the use is optional, and without reference to change in circumstances, it belongs to the class of spontaneous variations, and does not explain why those of one type of variation (or of one kind of choice) should be brought together and limited to so small an area.

Relations of the Genera

The relations of the genera of Achatinellinæ involve problems of still greater interest, but more difficult to penetrate. The limits of this paper render it impossible to do more than to give some of the most striking facts, and indicate some of the questions that arise.

Through the varieties of *A. oviformis* and *B. Sowerbyana*, the genus *Achatinella* passes by minute gradations into *Bulimella*; but connections of this kind have not been noted between the other genera.

The family is divided into two natural groups of genera. The first group consists of seven genera: *Achatinella, Bulimella, Helicterella, Partulina, Newcombia, Laminella*, and *Auriculella*. These are all arboreal in their habits. In form they are either sinistral, or both dextral and sinistral. The second group consists of three genera: *Amastra, Leptachatina*, and *Carelia*. With but few exceptions, the species of *Amastra* and *Leptachatina* live on the ground and are of dextral form. I am not informed concerning the habits of *Carelia*, but the structure of the shell and its invariably dextral form show that it belongs to this group.

Of the second group, *Carelia* is found on Kauai, the most western of the Sandwich Islands. The two remaining genera are found on all the islands. The first, or arboreal group, is represented on all the islands except Kauai. The separate genera are more restricted in their distribution. Two are found only on Oahu, a third on Oahu and Molokai, a fourth on Molokai and Maui, and the remaining two on several islands.

The genus *Helix* is represented on all the islands. So far as I know, the species all live on the ground, and are all dextral in form. They are all small in size, with spire very much depressed, and have no trace of the peculiar twist in the columella which characterises the Achatinellinæ.

Why should nearly all the ground species be dextral, and many, if not a majority, of the arboreal species be sinistral? Does this fact point to one common origin for the arboreal genera, and a separate origin for the ground genera? Or are we to suppose that arboreal habits tend to produce sinistral forms? The few species of *Amastra* which are found on trees retain the dextral form that belongs to the allied species living on the ground.

Facilities needed for the Study of Variation of Species

I am fully persuaded that the study of allied forms in their geographical relations is one of the richest fields open to the naturalist. He may here reap a harvest of facts throwing light on many of the questions that are now occupying the special attention of the scientific world.

To afford suitable opportunity for such studies, it is necessary that certain sections of our museums should be devoted to the exhibition of objects in an arrangement more strictly geographical than anything that has yet been attempted. The leading feature in the arrangement adopted by Agassiz in the museum at Cambridge, Massachusetts, is the geographical grouping of objects; but for the fuller presentation of the curious facts of geographical distribution, it is further needed that in certain wisely chosen families the objects should be laid down in their actual geographical relations, as on a map. It is not necessary that the map on which they are arranged should be as mathematically correct as a nautical chart. It will be sufficient if cases are prepared, approximately representing the territory or territories chosen, with subdivisions representing the different localities in which the specimens have been found.

Collections for such a purpose should be made with scrupulous care. The locality of every object should be noted with great minuteness. In collecting shells at the Sandwich Islands, noting the name of the island is not sufficient, nor yet the name of the district. Each valley, with its area two or three miles in length, and but one or two miles in width, needs to be separately explored, and all the shells labelled with the name of the valley. To show the relations of the species to each other, as complete a series as possible should be obtained of the countless varieties.

For this kind of study the fauna of the Sandwich Islands is of peculiar interest, on account of the number of forms, and the variety of relations presented within a small compass.

JOHN T. GULICK

EVANS'S STONE IMPLEMENTS OF GREAT BRITAIN*

II.

ONE of the arguments usually relied upon in support of the belief in fluviatile, as opposed to diluvial, agency in the formation of the deposits in which the Stone Implements are found, is founded on the assumption that the constituents of these quaternary gravels are petrologically such, and only such, as belong to existing river basins; and this fact, Mr. Evans says, holds good in France and England, and cannot be too often reiterated. Without pausing to consider how far this argument might avail as against those who, like Dr. Buckland, believe in a simultaneous and universal cataclysm, it seems hardly applicable to the conditions under which the implement-bearing drifts are found; for if the term petrological is to be understood as meaning rocks found *in situ* in the river basins, and thus native to the soil, then it is not the fact that the constituents of the gravels in question belong to those basins; for we know that they are often largely made up—in one instance cited by Mr. Evans to the extent of 50 per cent.—of the quartzose stones known as Lickey pebbles, and rounded fragments of jasper, quartz, and other foreign rocks. Such rocks certainly do not belong petrologically, in the proper sense of that term, to the river basins in which they occur, but to strata of a far earlier date. As Dr. Buckland has shown, the quartzite pebbles are derived from the New Red sandstone beds in Warwickshire and Leicestershire, and were at some remote period forced over the escarpment of the Oolite into the south and east of England. Whether they were brought in before or after the present river valleys were formed is not very clear, nor perhaps very material. It is incontestable that they were transported from a great distance, and possibly by the same forces that brought the flint gravels; and it is equally certain, in several instances, that their transport cannot be attributed to rivers now in action, because those rivers flow, as at Brandon, towards the quarter from which the stones were brought.

Nor, if it were certain that the intrusion of these rocks dated back to the Glacial Epoch, as is usually supposed, or to some other very distant period, and had thus become denizens, if not natives of the soil, could the inference which is drawn from the absence of extraneous rocks be regarded as satisfactory.

The occurrence of alternate elevations and depressions of the land above or below the sea level, during the post-glacial times, has been suggested by several English writers; and if we suppose that a district comprising the south of England and the north of France, corresponding, or nearly so, with that in which no boulder clay is found, to be sufficiently depressed, and then invaded by a deluge, the argument drawn from petrological conditions will cease to apply; for no rocks are found in the drift gravels but such as belong to the supposed deluge basin. A deluge of short duration would not necessarily introduce any foreign rocks into the submerged area, but would sweep into hollows and valleys those that came in its way; and even should the submergence be of long continuance, as in some provinces of Holland, it would leave no more traces than those exhibited in our drift gravels. That such a partial deluge was both possible and probable is evident when it is considered that a depression of 600 ft. would perfectly well effect it; and as we have evidence that the land has risen in several places 30 ft. and more within the historical period, it is not difficult to believe that in the infinitely longer time that probably intervened after the Glacial Epoch the same process of elevation may have been going on for many ages.

The absence of all traces of a marine fauna, and the occasional presence of land and freshwater shells in these beds, are circumstances on which much stress is laid by the author; but when fully considered they hardly seem to warrant the inferences drawn from them. A marine fauna requires a marine flora for its sustenance, and unless the submergence had been of long duration this could not have existed. We find extensive marine deposits of older date, in which no marine organisms are ever seen; and if marine fossils are wanting in drift beds, those of the land and freshwater are usually equally wanting. We have, probably, hundreds of square miles of quaternary gravels, in which not a single specimen has ever been discovered. In those instances, comparatively rare, in which they occur in the implement-bearing beds, they are usually lying above the gravel, and may thus be ascribed to a later date; or if of an earlier date in some instances, their occurrence would not of necessity exclude diluvial action, as regards the gravels.

There is one interesting topic connected with these drifts, which Mr. Evans has not dealt with at any length, as, indeed, it barely came within the design of his work; but he seems to share the general opinion that the men who made and used the drift implements were contemporary with the hippopotamus, elephant, rhinoceros, and other animals, with whose remains they are often found associated. At present this is but a possibility, and it is an assumption founded on the fact of the bones and implements being often found in close proximity, but if, as seems probable, the implements were formed from stones found in the gravels in which they now rest, it can hardly be doubted that the bones were already in that gravel, and may have lain there for centuries. From their shattered and way-worn condition, they have evidently been subjected to much rougher usage than that which some of the flint implements have met with. But however this may have been, there can be no doubt, as Sir Charles Lyell has observed in the "Antiquity of Man," that "the fabrication of the implements must have preceded the reiterated degradation which resulted in the formation of the overlying beds;" a process for which vast periods must be allowed, and one which must have involved important geological changes. Amongst others we have very strong reasons to believe was the severance of our island from the Continent, an event, indeed, which, however brought about, could hardly have been unattended with important changes in the contour of the adjacent districts, and the courses of their rivers. When we contemplate the vast changes, geological, palæontological, and geographical, which our race seems to have survived, we are surprised to learn how very old we are, or, as Mr. Evans has better expressed it, the mind is almost lost in amazement at the vista of antiquity thus displayed.

It would seem, as might be expected, that notwithstanding the cosmopolitan character of these objects—for, as Mr. Evans's researches have shown, they are found in one form or other in every country on the face of the globe—certain forms are pretty well confined to certain localities, as if each of the tribes or families who used them had its own manufacture. The half-polished and polished celts of Norfolk, Suffolk, and Cambridgeshire vastly outnumber those which have been observed in all other parts of England, from which it would seem that these counties were more populous, or the people more advanced in the arts, than in the rest of the island, or possibly they may have been the manufacturing district of the period. As regards, however, the distribution of the drift implements, a far more suggestive and important circumstance is to be noticed. As Mr. Evans has observed, the district farthest north of the Thames in the gravels of which flint implements are at the present time known to have been found, is the basin of the River Ouse and its tributaries. They have, in fact, been found at one time or other, in every English county lying to the south-east of a line drawn from

* "The Ancient Stone Implements, Weapons, and Ornaments of Great Britain." By John Evans, F.R.S., F.S.A. (London: Longmans and Co., 1872.)

the Severn to the Great Ouse, corresponding thus far with the great escarpment of the oolite, but they have never been met beyond that line; and it is an interesting subject of speculation to what the dearth of these objects in the country lying to the north-west is to be attributed. If it was habitable and inhabited, it is difficult to imagine a reason for their absence, especially as in Yorkshire and Lincolnshire there is abundance of suitable chalk flint. This line of demarcation is not very much out of that which separates the boulder clay districts from those in which no boulder clay is met with. May it not have been the case, that when the implements were fashioned, Scotland and the north-western parts of England were still submerged beneath the glacial sea, and that on their emergence the south-east became in its turn depressed?

Notwithstanding all that has been written on the subject, there seems to be still much doubt as to the uses for

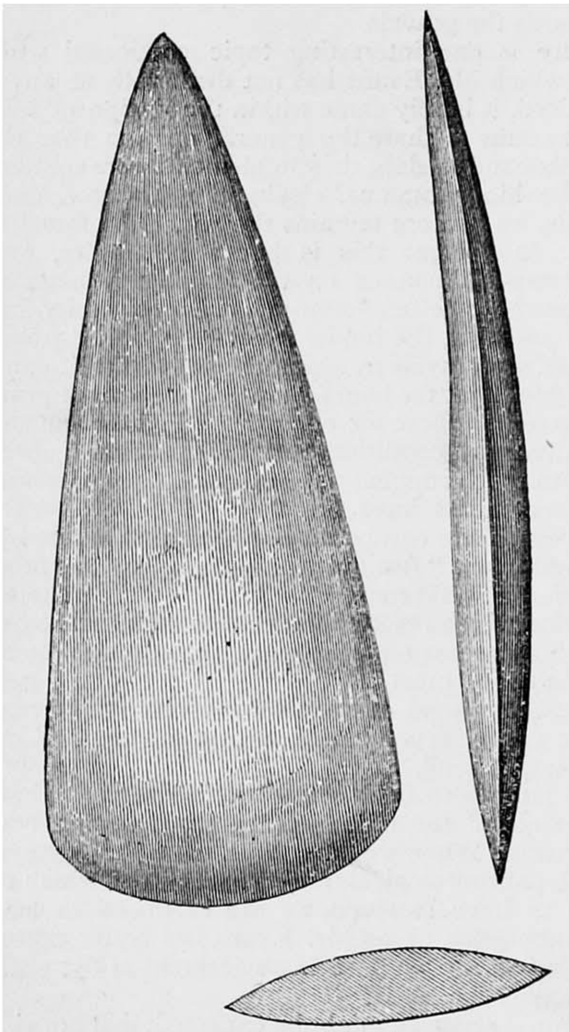

FIG. 1.—POLISHED CELT, BURWELL FEN, CAMBRIDGESHIRE

which some, and no inconsiderable number, of these objects were designed. For all useful purposes it would have sufficed that the cutting edge of a celt should alone be polished and ground; yet it is often, indeed usually, found that the entire surfaces of the faces and the sides exhibit a polish which could only have been obtained by long and apparently profitless labour. And not only so, but many of these are very fragile, being slightly made, and of delicate workmanship, and others are of such small dimensions, that, as M. Boucher de Perthes pointed out, they never could have been available for any kind of hard work. Many of these exhibit no signs whatever of fracture or even of scratching, either at the butt or the edge, indications which could not possibly have been wanting had they ever been used for weapons or tools. Besides which, while many of the districts in which they are found contain abundance of rocks suitable for all ordinary purposes, these implements are often made from Asiatic jade, jadeite, tremolite, serpentine, green porphyry, nephrite, and other stones of beautiful colours, and capable of taking a high polish, many of which must have been brought from great distances, and would have been very costly both to import and to work. The museums in Brittany, and particularly that at Vannes, are very rich in jadeite implements of this kind, but they are also found frequently both in England and Scotland. That of which a figure is here given (Fig. 1) was found in Burwell Fen, Cambridgeshire, and is described by Mr. Evans as being exquisitely polished, and a mottled pale green colour; the material is of a hard diorite, and as both faces are highly polished the labour bestowed on the manufacture must have been immense.

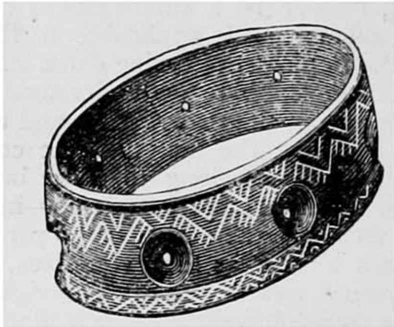

FIG. 2.—JET ARMLET, GUERNSEY

But if we conclude, as we must, with the author, that implements for which such beautiful and intractable materials were selected, could hardly have been in common use, we may indulge in some speculation as to what were the uses they were designed to serve, notwithstanding that, as Mr. Evans says, we have not sufficient ground for arriving at any trustworthy conclusion. M. Boucher de Perthes thought that they were deposited by the survivors in the graves of deceased friends, as useful to them on their resurrection, and he argued from this their belief in a future state. It seems, however, hardly probable that objects, many of which obviously could not be serviceable, should be placed in tombs under the belief that they would be so at some future date. In the absence of any more satisfactory explanation, it may be suggested that these things were intended by our remote

FIG. 3.—BRONZE ARMLET, GUERNSEY

predecessors to represent the deities whom they worshipped, and that by their varied sizes and shapes they indicated the ranks and orders of their idols. We may believe that men not having learned the art of representing the human or animal form, were obliged to content themselves with symbols of their divinities—it may be their Mars and Ceres—under the form of weapons of war, or instruments of agriculture. Nor is this so unlikely as it might otherwise appear, when we know that these celts are still objects of worship in India. Mr. Evans, quoting from the Proceedings of the Asiatic Society of Bengal, says that they are there venerated as sacred, and it is known that in a certain village in the Shewaroy hills some hundreds of polished celts, of varying sizes, resembling those found in England and Scotland, are preserved in a temple, arranged in rows. They are guarded with the utmost jealousy by the priests, each representing some particular *swamy* or deity, and each receiving from time to time a dab of red or white paint, as a proof that the priest has performed before it the customary *poojah* or worship.

FIG. 4.—HARPOON HEAD, KENT'S CAVERN

This being so, the discovery of these implements in Europe may have some bearing upon an important ethnological question. We have good reason to believe that the dolmen-builders came, in the first instance, from India, for we find in Wilts and Berks, and elsewhere, exact counterparts of some megalithic structures, and those of a peculiar construction, which yet remain in the same Shewaroy district in which the celt worship is still practised. May we not then regard it as possible that the fabrication of polished implements, as well as the practice of dolmen building, originated in India, where they are still retained, and that these costly polished celts were brought hither by our Aryan ancestors, as the Israelites carried their Teraphim about with them, or as the Trojans, after the fall of their city, are represented in Virgil as carrying with them their household gods:—

"Ilium in Italiam portans, victosque penates;"

and that the worship was only abandoned here as men became enlightened, or were subjected to the dominion of some race of a different theology? Since we find abundant traces of the Aryan language in our own, and of their sepulchral architecture in our dolmens, why should we not find in our fields and fens some of their idols? It is quite consistent with, and in a certain sense confirmatory of, such a belief, that in almost every country in which these things are found, they are regarded by the common people with superstitious reverence, as if the practice of adoration had in the lapse of ages merged in a vague and faint tradition of sanctity.

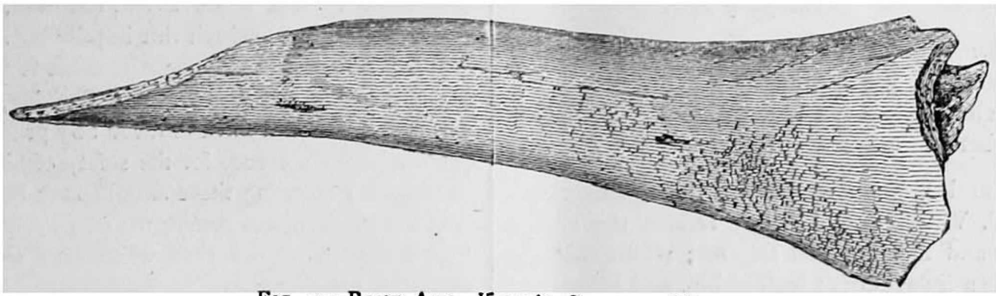

FIG. 5.—BONE AWL, KENT'S CAVERN. (1835.

Nor is it any objection to this hypothesis, but the reverse, that these implements are usually found in and about dolmens, as at Tumiac and Mont St. Michel, where nearly seventy highly polished celts of imported materials—Asiatic jade and hard tremolite—were found ranged in regular order. It has been usual with almost all people, in all ages, that those things which they most esteemed in life should rest with them in their graves; and as we often find in our own country the priest's paten and chalice placed in his coffin, or the Anglo-Saxon's sword and shield laid beside him in the earth; so, possibly, these Prehistoric men may have wished that the stone idols which, when living, they adored—the Lares and Penates of their time—should be laid beside them in their tombs.

But in pursuing the train of thought suggested by our author, we had well-nigh forgotten his book, and we have only space to congratulate all those who are interested in these researches—and they are now many—on the ample and valuable additions which he has made to this new and most interesting chapter in the history of our race.

NOTES

THE following officers have been elected for the Brighton Meeting of the British Association:—President-elect—Dr. William B. Carpenter, F.R.S. Vice-Presidents-elect—The Earl of Chichester, the Duke of Norfolk, the Duke of Richmond, the Duke of Devonshire, F.R.S., Sir John Lubbock, Bart., M.P., F.R.S., Dr. Sharpey, Sec. R.S., Mr. Joseph Prestwich, F.R.S., Pres. G.S. Section A: Mathematical and Physical Science. President—Warren De La Rue, F.R.S. Vice-Presidents—J. Norman Lockyer, F.R.S.; Lord Rosse, F.R.S; Prof. H. J. Stephen Smith, F.R.S. Secretaries—Prof. W. K. Clifford, R. A. Proctor, A. C. Ranyard. Section B: Chemical Science. President—Dr. J. Hall Gladstone, F.R.S. Vice-Presidents—F. A. Abel, F.R.S.; Prof. Williamson, F.R.S. Secretaries—Dr. Mills; W. Chandler Roberts; Dr. W. J. Russell, F.R.S.; T. Wood. Section C: Geology. President—R. A. C. Godwin-Austen, F.R.S. Vice-Presidents—Thomas Davidson, F.R.S.; Prof. P. M. Duncan, F.R.S.; Rev. T. Wiltshire. Secretaries—Henry Woodward, Louis C. Miall, G. Scott, William Topley. Section D: Biology. President—Sir John Lubbock, Bart., M.P., F.R.S. Vice-Presidents—John Ball, F.R.S.; Dr. Beddoe; Prof. Flower, F.R.S.; Colonel A. Lane Fox; J. Gwyn Jeffreys, F.R.S.; Dr. Burdon Sanderson, F.R.S. Department of Zoology and Botany. Sir John Lubbock, Bart., M.P., will preside. Secretaries—Prof. Thiselton Dyer; H. T. Stainton, F.R.S. Department of Anatomy and Physiology. Dr. Burdon Sanderson, F.R.S., will preside. Secretaries—Dr. Gamgee, F.R.S.; E. Ray Lankester; Dr. Rutherford; Dr. Pye-Smith. Department of Anthropology. Colonel A. Lane Fox will preside. Secretaries—Dr. Charnock, F. W. Rudler, J. H. Lamprey. Section E: Geography. President—Francis Galton, F.R.S. Vice-Presidents—Clements R. Markham; Major-General Sir Henry Rawlinson, Bart., F.R.S., Pres. R.G.S.; Major-General Strachey, F.R.S. Secretaries—H. W Bates, A. Keith Johnston, Rev. J. Newton, J. H. Thomas. Section F: Economic Science and Statistics. President—Prof. Henry Fawcett, M.P. Vice-Presidents—R. Dudley Baxter, William Newmarch, F.R.S. Secretaries—J. G. Fitch, Edmund Macrory, Barclay Phillips. Section G: Mechanical Science. President—Frederick J. Bramwell, C.E. Vice-Presidents—John Hawkshaw, F.R.S.; C. W. Merrifield, F.R.S.; Charles B. Vignoles, F.R.S. Secretaries—H. Bauerman, J. Gamble. The First General Meeting will be held on Wednesday, August 14, at 8 P.M. precisely, when Prof. Sir William Thomson, F.R.S., will resign the Chair, and Dr. W B. Carpenter, F.R.S., will assume the Presidency, and deliver an Address. On Thursday Evening, August 15, at 8 P.M., a Soirée; on Friday Evening, August 16, at 8.30 P.M., a Discourse on Insect Metamorphosis, by Dr. P. M. Duncan, F.R.S; on Monday Evening, August 19, at 8.30 P.M., a Discourse by Prof. Clifford; on Tuesday Evening, August 20, at 8 P.M., a Soirée; on Wednesday, August 21, the Concluding General Meeting will be held at 2.30 P.M.

THE next meeting of the American Association for the Advancement of Science will not be held at San Francisco, as previously announced, but at Dubuque, commencing August 21.

THE following telegram respecting the Livingstone Search Expedition has been forwarded from the office of the Submarine Telegraph Companies in India:—"ADEN, July 11.—Stanley arrived, and leaves to-day by French steamer for Suez, with Livingstone's son. Has letters from Livingstone to the Government and friends. Found Livingstone unwell, but determined to go farther on, and not return before completing perfectly his work. Stanley's men return and accompany him."

IT is stated in *L'Institut* that the Académie des Sciences of Paris, at its last two sittings, has been again discussing in secret whether it will do itself the honour of admitting Mr. Darwin as a corresponding member in the section of Zoology.

THE chair of Natural History at Owens College has been divided. Prof. W. C. Williamson, F.R.S., retains the charge of Animal Phisiology and Zoology and Botany; whilst Geology has been erected into an independent lectureship, and committed to Mr. W. Boyd-Dawkins, F.R.S., the curator of the Natural History Museum.

WE learn from *Les Mondes* that the French Budget Commission has opened provisionally to the Minister of Public Instruction a credit of 100,000 francs, to be appropriated to the collection of the special instruments necessary to the observation of the transit of Venus which takes place on December 8, 1874. The work of collection is being pursued with great activity at the Imperial Observatory, under the direction of M. Alphonse Martin.

THE Academy of Sciences in Bologna has announced that a prize of 1,200 *lire* (48*l.*), the "Aldini Prize," will be awarded to the author of the best scientific experimental essay on galvanism or dynamic electricity. Essays intended for the competition must be sent in between July 1, 1872, and June 30, 1874, and must be written in Italian, Latin, or French. They must be either written or printed; but, in the latter case, must not have been published previously to the two years above mentioned. Each essay is to bear a motto, and to be accompanied with an envelope stating the name of the author. They must be addressed to the Perpetual Secretary of the Academy of Sciences of the Bologna Institution.

THE *Melbourne Argus* states that valuable work is being performed with the great telescope at the Melbourne Observatory. At a recent meeting of the Royal Society, Mr. Ellery, the Government Astronomer, stated that some photographs of the moon had been obtained better than any he had any knowledge of. The picture of the moon taken in the telescope was about three inches in diameter, while the primary pictures of the photographs of the moon hitherto made public by Mr. De La Rue were only three-quarters or seven-eighths of an inch in diameter, though subsequently enlarged to something like two feet.

THE *Times of India* of June 21 prints at length the judgment of the Marine Court of Inquiry into the disasters attending the recent cyclone at Madras. The judgment contains the following chronicle of the weather changes during the three days preceding the cyclone:—On the afternoon of Monday, April 29, the wind shifted from the S.S.E. to the N.E., a bank of clouds forming to the S.E. The weather became gloomy, with lightning; the barometer falling slightly. On Tuesday morning the barometer had fallen, wind and sea had increased from the N. and E., with squalls, rain, and suspicious appearances generally, surf rising, and the current at the shipping changing to the S. During the night there were heavy squalls, with rain, thunder and lightning. It was blowing hard in gusts; sea increasing, and weather still getting worse. On Wednesday, May 1, the weather had a very wild appearance, a heavy squall with surf; wind about N.N.E. Very heavy squalls, with rain; fresh gale between the squalls. Towards afternoon it was blowing very hard; barometer falling. The barometric tide existed, but the mercury was lower in the tube, the current at the shipping setting stronger to the S. There appears to have been a break in the clouds to the N.E. in the evening, and the wind moderated, though still blowing hard, the barometer remaining depressed. Towards midnight on Wednesday the barometer commenced to fall rapidly, and the wind and sea increased to fury; several of the native vessels broke adrift, followed, after daylight, by the English vessels, to which this inquiry is directed. On consideration of the whole evidence, the court is "forced to a conclusion that during the day and night of Tuesday, April 30, the weather was such as should have induced any prudent man to take every precautionary measure for the safety of his ship; and that from Wednesday morning there should have been no reasonable doubt that the premonitory symptoms of a cyclone existed;" especially "at a season of the year when bad weather and cyclones are expected on this coast." Experience, the judgment declares, shows that the chances in favour of a vessel surviving a cyclone by putting to sea in time greatly preponderate. It will be seen from this that no blame whatever is attributed by the Court of Inquiry to Mr. Pogson.

THREE very remarkable paintings are now being exhibited at No. 7, Haymarket, called "Arctic Summer," "Crushed among the Icebergs," and "Arctic Wreckers." In the year 1869 the artist, Mr. Bradford, chartered the steamer *Panther*, of St. John's, Newfoundland, and, inviting Dr. Hayes, the well-known arctic explorer of America, to accompany him, sailed from the above port for the sole purpose of getting sketches of the hitherto unknown frozen north. Reaching the latitude of 76° N. in Melville Bay, he remained there until the middle of August, when the new ice began to form so fast that it was with great difficulty they could force their way through the pack. Two experienced photographers accompanied the expedition, and obtained most wonderful views of the arctic scenery. From the photographs, and his own sketches, Mr. Bradford has now produced these paintings, which must give a more perfect idea of the wonders of the arctic regions to those who have never visited them than any description could possibly do. It is difficult otherwise to realise the gigantic height of some of the ice-walls, the sea-fronts of the glaciers, from which the huge icebergs break off and drift southwards. Mr. Bradford will shortly publish a work, illustrated by over eighty of the finest photographs, showing the different phases of life in those regions—the great glaciers, fiords, mountains, Esquimaux life, icebergs, and the ice phenomena of Melville Bay; the edition will be limited to 250 copies.

THE first number is issued of a new monthly magazine, price 6*d.*, entitled *Grevillea*, a record of Cryptogamic Botany and its literature, edited by Mr. M. C. Cooke. It is intended as a medium of communication among cryptogamists, chronicling discoveries of new species, physiological observations, and other matters of interest, and will doubtless fill a useful place. In the present number, which is illustrated by a coloured plate, the fungologist, lichenologist, bryologist, algologist, and diatomologist will each find something to interest. If well supported by those interested in this branch of botany, it ought to become indispensable to all who wish to become *au courant* with the present position of cryptogamy.

PROFESSOR AGASSIZ'S SOUTH AMERICAN EXPEDITION*

II.

FOR reasons which I will explain presently, I would mention especially pebbles of a red porphyry, and others of a green compact epidote, as common in the Port San Antonio formation. The position of the Bay of San Mathias, its great length, and more particularly the depression or denudation at Port San Antonio, suggest the probability that the Rio Negro once poured its waters into this large gulf instead of opening directly into the ocean. I should add that while erratic pebbles occur in such abundance at San Mathias Bay, there are no hard rocks in place upon which the peculiar marks of glacial action could be perceived. Nor would these stratified banks of pebbles, even though unquestionably connected with the drift, afford in themselves any unmistakable evidence of glacial derivation.

As time and the circumstances of our vessel obliged me to renounce the hope I had cherished of seeing at least the mouth and the shore bluffs of the Rio Negro, Santa Cruz, and Gallagos Rivers, and also of visiting the Falklands, I could not connect my observations in San Mathias Bay with any other facts on the eastern coast of Patagonia or its outlying islands. But after rounding Cape Virgens we came into Possession Bay, where the geology along the shore was of a most interesting character. All along the northern shores of the Straits of Magellan the tertiary formation observed on the eastern shore of Patagonia is plainly distinguishable even from a distance by its horizontal beds, which are also visible upon the Fuegian coast. In Possession Bay we landed to examine more closely the character of the country, some of us with the intention of exploring more particularly the terraces above the shore bluffs; while others were bent upon a longer excursion to Mount Azmon and adjoining hills.

About a mile from the shore bluff I found, nearly 150 ft. above the sea level, a salt pool in which, to my great surprise, marine shells identical with those now living along the shore were abundant. They were in a perfect state of preservation, and many of them were alive; so that I gathered a number of specimens with the living animal, whi h I have preserved in alcohol. The most common were *Mytilus*, *Buccinum*, *Fissurella*, *Patella*, *Voluta*, &c., all found in apparently the same numerical relation as that in which they now exist in the sea below the cliff. The presence of this pool with its living inhabitants shows a very recent upheaval of the coast. The period at which it may have taken place it is hardly possible to determine without a more extensive survey. As the facts stand, it is a most valuable confirmation of Darwin's assertion of recent upheavals on this shore, published more than thirty years ago; though he attributes phenomena to this cause, and connects with it facts which had, in my opinion, a different origin and another significance. At the season of our visit to Possession Bay, in March, when autumn is approaching in this hemisphere, the pool was nearly dry, and the little water left in it was intensely saline. Dr. White has examined it chemically, and handed me the following report of his analysis:—"The specimen of water obtained from the pond at Possession Bay was found to contain magnesia, lime, sulphuric acid, chlorine, a small quantity of iron, and a trace of iodine. It was about $2\frac{1}{3}$ times as dense as ordinary sea water, as shown both by hydrometric observation and by the total amount of chlorine present; organic matter in excess." The shores of the pond showed plainly that in the rainy season it is three or four feet deep, when no doubt the water is more like sea water than at the time of our visit. From the innumerable tracks of guanacos, it must be the constant resort of these animals, and, indeed, during the day we saw many of them moving in that direction. A more palpable evidence of upheaval has not, as far as I know, been observed before. Dead marine shells scattered over dry land are not always conclusive evidence of the former presence of the ocean, for they may have been dropped by birds or other animals; but a salt pond more than 100 ft. above the sea level, with the same shells alive as those now found on the shore, could only be produced by an upheaval. The land beyond the first shore bluff is horizontal. It rises in regular terraces to about 400 ft. above the level of the sea. This is also the general level of the country, the surface of which is much ravined and furrowed. I counted eight such terraces above the beach. They all consist of tertiary deposits; but upon the beach itself three lower levels may be distinguished, their relative age being marked by the presence or absence of vegetation on the sand.

* Reprinted from the *New York Tribune*.

Upon the third terrace, a little above and more inward than the salt pool, at the height of at least 150 ft. above the sea, I found a distinct moraine, in which the scratched pebbles were mingled with the simply rounded ones in as large a proportion as in any front moraine in actual contact with a glacier. This moraine was arched, with the convexity turned northward, and the abrupt slope southward, showing that the motive power which had brought and left it there must have moved from the south in a northerly direction. Higher up, to a level of about 400 ft. above tide water, there are also erratics scattered over the plain. At the level of 400 ft.—the highest to which I ascended—I saw a number of large, angular boulders.

Here are facts, then, of great significance in close proximity, namely, a pool containing marine shells alive, more than 100 ft. above the level of the sea, showing a very recent rise of the tract of land it occupied; and an accumulation of pebbles and boulders having all the characters of a glacial moraine, resting upon one of numerous terraces, which seem to mark successive upheavals of the country. That these retreating levels only simulate the successive steps of a gradual upheaval, and are in fact no evidence of such an occurrence, is proved by the geological constitution of the ground, which is entirely made up of regular tertiary beds, without a trace of shore pebbles. Darwin, who has also observed the phenomena of subsidence and upheaval characteristic of this region, was led to believe that the drift was scattered over Patagonia by icebergs while the country was submerged. The moraine upon one of these terraces mentioned above shows, however, that the upheaval must have taken place before the dispersion of the drift, and not after. I say nothing here of Pourtales's very interesting discovery of an extensive field of extinct volcanoes to the north of Possession Bay, of which Mount Azmon is the largest, since he has already sent you an official report on the subject. His observations are among the most valuable results of our geological work. The suggestion presents itself at once that the upheaval of the region may be connected with the former activity of those volcanoes. Throughout the eastern part of the Straits of Magellan the shores exhibited tertiary formations such as we had traced along the Atlantic coast of Patagonia and in San Matthias Bay. Of course in deposits of this kind we could not expect to find any trace of smooth polished rocks.

The last localities of recent geological age which we examined carefully were Elizabeth and Magellan Islands. The latter is almost entirely made up of glacial drift, among which there are a good many large and small boulders with very smooth surfaces and characteristic scratches, and some of them are of the same red porphyry and epidote mentioned before. At Sandy Point large accumulations of boulders are scattered over the whole country, and the streets of the settlement are paved with them. They are easily observed in their natural position on the banks of the river, and in the cuts of the railroad leading to the coal mines. Here the drift is auriferous. Señor Viel, governor of the colony, gave me very fine specimens of the gold collected in the immediate neighbourhood of the settlement. I was also much interested in the coal deposit. There are two considerable seams of coal, one 6 ft. 6 in. thick, and another, 80 ft. higher up, 3 ft. thick. The few species of fossils which I obtained there in great quantity left upon me the impression that the coal is not tertiary, but belongs to the cretaceous formation. The most characteristic of these fossils is an oyster, of the type of the *Ostrea deltoidea*, forming beds many feet in thickness.

After passing Sandy Point the country assumes a completely different aspect. The mountains rise to great heights on both sides of the channel, in consequence of which the region may be compared to the Alps, even though the loftiest peaks, such as Mount Sarmiento, Mount Darwin, Mount Buckland, Mount Barney, only measure from 6,000 ft. to 7,000 ft. But as their base is washed by the ocean, and their slope is very steep, they appear much higher than they really are.

The neighbourhood of Sandy Point will ever be especially interesting to Swiss geologists, from the fact that it recalls many familiar scenes. Pourtales and I greatly enjoyed the comparison with home scenery. In his work on the "Rocks of the Two Hemispheres," and in his "Kosmos," Humboldt repeatedly alludes to the striking similarity of the features exhibited by the inorganic world in regions very distant from each other, and I only follow in his footsteps if I say that Sandy Point and the tracks north of it recalled to me the Jura and the more level country at its foot, while the higher ranges to the south reminded me of the Alps. The comparison might be carried into detail without exaggeration. The first chain in sight from the channel, in which the coal deposits are found, rises only to about 1,000 ft., and resembles the Neocomian hills skirting the western Jura; while the second chain, rising to about 2,500 ft., may be compared to Chaumont, or some other of the less elevated summits of the same range. Even the ravine leading to the coal mine brought back to me the gorges on Seyon, with its torrent; while the flats below stand in the same relation to the hills as the alluvial Pointe du Bied and the tertiary plain of Berex holds to the Jura. This resemblance is not simply superficial; it actually extends to the geological structure of the whole region. The higher mountains to the south, though recalling the Alps, should not be compared with the highest Swiss ranges, such as Mont Blanc, Mont Rosa, or the Bernese Oberland; they have more the character of the Osmonds. Mont Jura, for instance, when seen from the north, reminds one of the Niesen, or some of the conical heights rising above Meilleiries, such as the Cornette de Brise; when seen from the east it may be likened to the Untersberg, near Saltzburg. Mount Sarmiento, Mount Buckland, Mount Barney, and many others less known, have truly the character of the highest Alps. Mount Buckland resembles the Matterhorn very strikingly in form, except that its surface is entirely shrouded in ice.

It was not till we rounded Cape Froward that I felt confident that the range of hills immediately in sight along the channel we followed had assumed their present appearance in consequence of abrasion by ice. Now, however, that I have seen the whole length of the Straits of Magellan, have passed through Smyth's Channel, and visited Chiloe, I am prepared to maintain that the whole southern extremity of the American Continent has been uniformly moulded by a continuous sheet of ice. Everywhere we saw the rounded undulating forms so well known to the students of glacial phenomena as *roches moutonnées*, combined with the polished surfaces scored by grooves and furrows running in one and the same direction; while rocks of unequal hardness, dykes traversing other rocks, slates on edges, were all cut to one level. In short, all the surface features of the Straits of Magellan have much the same aspect as the glaciated surfaces of the Northern Hemisphere. Whenever the furrows and scratches were well preserved their trend was northern.

I have recorded carefully every locality having a special interest in reference to those facts. I will here only mention a few of the most characteristic ones. The first unquestionable *roches moutonnées* I saw were upon the nearest coast opposite Cape Froward—as the English maps have it—where the rocks are bent and twisted, as those of the Dent du Midi and the Dent de Morchi. Cape Frouart—for such is the French name given by Frezier to the southernmost promontory of the continent—is itself rounded and polished, most especially on its south-west exposure, with rugged crests as above the Grimsel in the Nägeli's Grath. All the hills between Snug Harbor and Wood Bay are equally rounded and polished to their very top. Even the wooded part of the slope shows the characteristic undulations of glaciated hill-sides. Many hills and mountains east and west of Cape Holland exhibited the same aspect. I was particularly struck with the appearance of a gentle slope between Cape Holland and Point Coventry, the surface of which exhibited some naked knolls distinctly glaciated, while the wooded part of the hill had the same form. All these mountains recall the Vor Alps, such as the Moleson, the Faulhorn, the Rhigi, and the Pilates, rather than the Alps themselves, even when entirely covered with *névé* or ice. These rounded knolls and glaciated surfaces penetrate frequently into the narrow coves which open into the main channel, in a north-south direction, at right angles with the Straits themselves—thus showing that the grinding agent must have moved from the south northward or from the north southward, and not from east to west or from west to east, as the Straits mainly trend. In Port Gallant, I saw large and small pebbles, and large boulders, many at least 6 ft. in diameter, and one measuring 12 ft. by 6 ft. and 5 ft., well rounded, and more or less polished, with rectilinear scratches in different directions all over their surface—in fact, such as are only found in genuine ground moraines.

The whole of Fortescue Bay, with the exception of a small land beach, on which we found a Fuegian camp, is covered with erratics. Even within high and low water mark many pebbles still show glacial scratches, though they are constantly tossed to and fro by the tides. Pourtales had the good fortune to be the first to see genuine glacier scratches, above Port Gallant, upon polished rocks in place. It was upon the surface of a quartz dyke traversing talcose slate. The trend of the scratches was west-north-west. There are *roches moutonnées* all the way from Fortescue Bay to Jerome Point, Cross Mountain included. Jerome Point itself is well polished, especially on the south side. York River Valley, which trends northward, is also well polished on both sides. Between the last two ranges of Jerome Point, westward, there is a cove trending northward, in which the *roches moutonnées* are as characteristic as upon the sides and face of the whole Point. The gorge opposite is equally *moutonnée* on both sides, showing that the denudation has not yet been the work of an agent moving east-west or west-east through the main channel. The two heads of the narrowest part of the straits (El Morion and Cape Gnod) are beautifully polished and rounded. The last range of Jerome Point seems to show that the abrading cause acted from S.S.W. to N.N.E. In Borgia Bay the ground is covered with large pebbles and boulders, some of the largest of which are rounded, polished, and scratched. Pourtales and Kennedy ascended the peak marked 1,923 upon the Admiralty map of Borgia Bay, and found *roches moutonnées* to the height of about 1,500 ft., while higher up the rocks were broken into rugged ridges. The whole scenery reminded me of the Abschwartz, above the glacier of the Aar. Some of the polished surfaces resembled, in the most surprising manner, places represented in my works upon the glaciers, and might have served as models for the illustrations I published of the glacial phenomena in Switzerland more than thirty years ago. No promontory in the whole extent of the straits, seen from either its eastern or its western side, shows as probable a strike-side of the polishing agent as the north and south exposures; leading to the presumption that the planing-machine has moved north and south, even though every surface seems almost equally well polished. Nothing indicates the fitful action of icebergs. Glacier Bay has also been for me a most fruitful field of study; but of this more in detail later. In the harbour of Sholl Bay there are several concentric moraines marked by boulders and kelp, which may have been deposited by the great glacier on the opposite side of the channel.

With all the evidences of glacier action constantly before our eyes, the journey from Cape Frouart to Cape Tamar was nevertheless tantalising to me, because it gave no opportunity for tracing the facts in unbroken continuity. The course of the Straits of Magellan bearing mainly in an east-westerly direction cuts everywhere at right angles, the effects produced by the southern ice-shoes upon the solid foundation of the whole track. Only after we had rounded Cape Tamar and passed Sholl Bay did we enter a channel bearing in the same direction with the glacial erosion, and thus affording an opportunity of following connectedly on the opposite sides of the whole channel, as far as the Gulf of Pennas, the traces left by glaciers upon the surface of the rocks. Here, as in reference to the Straits of Magellan, I shall describe only such localities as have a marked interest, reserving more details for another occasion. The facts spoke so plainly that even those not familiar with them were struck by their distinctness. Following the inside route through Smyth's Channel to the Gulf of Pennas, we were all the way within touching distance of the rocky walls of those narrow passages, so that nothing could escape us, and as the intricacy of the channels forebade travelling by night, we lost nothing in that way.

The Andes proper begin at Cape Providence, within the Straits of Magellan, but their alpine character is not strikingly developed south of Union Sound, even though at the bottom of Glacier Sound very high mountains with large glaciers may be seen. Mount Burney may be compared to Mount Sarmiento; still, throughout Smyth's Channel, until coming into Collingwood Strait, through Victory Pass, the scenery is very much like that of the Straits. In the southern parts of Smyth's Channel, I for the first time noticed un unmistakable difference between the southern and northern exposures of the nearer ranges trending N.S. Here it became every hour more plain that the strike-side of the glacial agency was upon the southern slope, and the lee side upon the northern. As soon as the Cordillera of Sarmiento opens into view the grandeur of the range is fully displayed. From the highest mountains glaciers depend to the sea level, which may be fairly compared to the most impressive glaciers of Switzerland. Throughout this region, as well as in other parts of the Straits, the nomenclature of the islands and mountains, as adopted upon the Admiralty chart, has a character very pleasing to a scientific man, and very creditable to those who have wished to connect the memory of their distinguished contemporaries and friends with their own investigations. Indeed, the names of all the prominent men of England, distinguished for their devotion to science thirty-five or forty years ago, form now a part of the physical geography of these regions. With these are associated some foreign names which, however, are not always so happily applied, very eminent names being, in some instances, given to very insignificant localities. We had twice a beautiful view of Mount Burney; first coming up through Mayne Channel, where we had an opportunity of seeing the vast difference between its aspect when covered with snow to the very base, as represented by Dr. Cunningham, and as we saw it, with its upper part only shrouded in perpetual snow and ice. It will be long before the real level of perpetual snow is ascertained in these regions, as any boisterous day may change the appearance of a mountain range to an astonishing degree. The mountains to the north of Cape Providence, Mount Burney, the Cordillera of Sarmiento, and the mountain ranges east and north of Snowy Glacier, form part of one and the same chain, and are in reality the southern termination of the Andes. L. AGASSIZ

(To be continued.)

ON THE SPECTRUM OF THE GREAT NEBULA IN ORION, AND ON THE MOTIONS OF SOME STARS TOWARDS OR FROM THE EARTH *

IN my early observations of the spectrum presented by the gaseous nebulæ, the spectroscope with which I determined the coincidence of two of the bright lines respectively with a line of nitrogen and a line of hydrogen, was of insufficient dispersive power to show whether the brightest nebular line was double, as is the case with the corresponding line of nitrogen.

Subsequently I took some pains to determine this important point by using a spectroscope of greater dispersive power. I found, however, that the light furnished by the telescope of eight inches aperture, to which the spectroscope was attached, was too feeble, even in the case of the brightest nebulæ, to give the line with sufficient distinctness when a narrow slit was used. The results of this later examination are given in a paper I had the honour of presenting to the Royal Society in 1868. I there say † :—

"I expected that I might discover a duplicity in the line in the nebula corresponding to the two component lines of the line of nitrogen, but I was not able, after long and careful scrutiny, to see the line double. The line in the nebula was narrower than the double line of nitrogen; this latter line may have appeared broader in consequence of irradiation, as it was much brighter than the line in the nebula." When the spark was placed before the object-glass of the telescope, the light was so much weakened that one line only was visible in the spectroscope. "This line was the one which agrees in position with the line in the nebula, so that under these circumstances the spectrum of nitrogen appeared precisely similar to the spectra of those nebulæ, of which the light is apparently monochromatic. This resemblance was made more complete by the faintness of the line; from which cause it appeared narrower, and the separate existence of its two components could no longer be detected. When the line was observed simultaneously with that in the nebula, it was found to appear but a very little broader than that line." I also remark :—"The double line in the nitrogen-spectrum does not consist of sharply defined lines, but each component is nebulous, and remains of a greater width than the image of the slit.‡ The breadth of these lines appears to be connected with the conditions of tension and temperature of the gas. Plücker states that when an induction-spark of great heating-power is employed, the lines expand so as to unite and form an undivided band. Even when the duplicity exists, the eye ceases to have the power to distinguish the component lines, if the intensity of the light be greatly diminished." I state further :—"I incline to the belief that it [the line in the nebula] is not double."

One of the first investigations which I proposed to myself when, by the kindness of the Royal Society, I had at my command a much more powerful telescope, was the determination of the true character of the bright line in the spectrum of the nebula, which is apparently coincident with that of nitrogen. From various circumstances, chiefly connected with the alterations and adjustments of new instruments, I was not able to accomplish this task satisfactorily until within the last few months.

Description of Apparatus

It seems to me desirable to give a description of the spectroscopic apparatus with which the observations in this paper were made. In the former paper, to which I have already referred, I gave some reasons* to show that the ordinary method of comparison, by reflecting light into the spectroscope by means of a small prism placed before one half of the slit, is not satisfactory for very delicate observations unless certain precautions are taken. I then describe an arrangement for this purpose, which, with one or two modifications, is adopted in the collimator constructed for use with the Royal Society's telescope. I give the description from that paper† :—

"The following arrangement for admitting the light from the spark appeared to me to be free from the objections which have been referred to, and to be in all respects adapted to meet the requirements of the case. In place of the small prism, two pieces of silvered glass were securely fixed before the slit at an angle of 45°. In a direction at right angles to that of the slit, an opening of about $\frac{1}{10}$ inch was left between the pieces of glass for the passage of the pencils from the object-glass. By means of this arrangement, the spectrum of a star is seen accompanied by two spectra of comparison, one appearing above, and the other below it. As the reflecting surfaces are about 0·5 inch from the slit, and the rays from the spark are divergent, the light reflected from the pieces of glass will have encroached upon the pencils from the object-glass by the time they reach the slit, and the upper and lower spectra of comparison will appear to overlap to a small extent the spectrum formed by the light from the object-glass. This condition of things is of great assistance to the eye in forming a judgment as to the absolute coincidence or otherwise of lines. For the purpose of avoiding some inconveniences which would arise from glass of the ordinary thickness, pieces of the thin glass used for the covers of microscopic objects were carefully selected, and these were silvered by floating them upon the surface of a silvering solution. In order to ensure that the induction-spark should always preserve the same position relatively to the mirror, a piece of sheet gutta-percha was fixed above the silvered glass; in the plate of gutta-percha, at the proper place, a small hole was made of about $\frac{1}{20}$ inch in diameter. The ebonite clamp containing the electrodes is so fixed as to permit the point of separation of these to be adjusted exactly over the small hole in the gutta-percha. The adjustment of the parts of the apparatus was made by closing the end of the adapting-tube, by which the apparatus is attached to the telescope, with a diaphragm with a small central hole, before which a spirit-lamp was placed. When the lines from the induction-spark, in the two spectra of comparison, were seen to overlap exactly for a short distance the lines of sodium from the light of the lamp, the adjustment was considered perfect. The accuracy of adjustment has been confirmed by the exact coincidence of the three lines of magnesium with the component lines of *b* in the spectrum of the moon."

The modifications of this plan consist in the substitution of a thin silver plate polished on both surfaces for the pieces of silvered glass. The opposite side of the silver plate to that from which the terrestrial light is reflected to the slit reflects the images formed by the object-glass to the side of the tube where a suitable eye-piece is fixed. This arrangement forms a very convenient finder, for it is easy to cause the image of the star to disappear in the hole in the silver plate. When this is the case the line of light formed by the star falls on the slit, and its spectrum is visible in the spectroscope. This collimator is so constructed that, by means of a coupling screw, any one of three spectroscopes can be conveniently attached to it.

This apparatus performs admirably; but it seemed to me desirable, for observations of great delicacy, to be able to dispense with reflection, and to place the source of the light for comparison directly before the slit. Formerly I accomplished this object by placing the spark or vacuum-tube before the object-glass of the telescope. The great length of the present telescope renders this method inconvenient; but a more important objection arises from the great diminution of the light when the spark is removed to a distance of 15ft. from the slit. I therefore resolved to place the spark, or vacuum-tube, within the telescope at a moderate distance from the slit. For this purpose holes were drilled in the tube opposite to each other, at a distance of 2ft. 6in.

* By William Huggins, LL.D., D.C.L., F.R.S. Paper read before the Royal Society, June 13, 1872.
† Phil. Trans. 1868, pp. 542, 543.
‡ Phil. Trans. 1863, p. 13.

* Phil. Trans. 1868, pp. 537, 538.
† Phil. Trans. 1868, p. 538.

within the principal focus. Before these holes short tubes were fixed with screws; in these tubes slide suitable holders for carrying electrodes or vacuum-tubes. The spark is thus brought at once nearly into the axis of the telescope. The final adjustment is made in the following manner:—A bright star is brought into the centre of the field of an ordinary eye-piece; the eye-piece is then pushed within the focus, when the wires or vacuum-tube can be seen across the circle of light formed by the star out of focus. The place of discharge between the electrodes or the middle of the capillary part of the vacuum-tube is then brought into the centre of the circle of light. The vacuum-tubes are covered with black paper, with the exception of a space about a ¼ inch long in the middle of the capillary part, through this small uncovered space alone can the light escape to reach the slit.

The accuracy of both methods of comparison, that by reflection and that by the spark within the tube, was tested by the comparison of the three bright lines of magnesium and the double line of sodium with the Fraunhofer lines *b* and D in the spectrum of the moon. I greatly prefer the latter method, because it is free from several delicate adjustments which are necessary when the light is reflected, and which are liable to be accidentally displaced.

Spectroscope A is furnished with a single prism of dense glass with a refracting angle 59° 42′, giving 5° 6′ from A to H.

Spectroscope B has two compound prisms of Mr. Grubb's construction, which move automatically to positions of minimum deviation for the different parts of the spectrum. Each prism gives about 9° 6′ for minimum deviation from A to H.

Spectroscope C is furnished with four similar prisms.

The small telescopes of the three spectroscopes are of the same size. Diameter of object-glass 1¼ inch; each is furnished with three eye-pieces magnifying 5·5, 9·2, and 16·0 diameters.

Spectrum of the Nebula of Orion

With spectroscopes A and B four* lines are seen.

First line.—With spectroscope B and eye-piece 1 and 2, the slit being made very narrow, this line was seen to be very narrow, of a width corresponding to the slit, and defined at both edges, and undoubtedly not durable. The line of nitrogen when compared with it appeared double, and each component nebulous and broader than the line of the nebula. This latter line was seen on several nights to be apparently coincident with the middle of the less refrangible line of the double line of nitrogen. This observation was on one night confirmed by observation with the more powerful spectroscope C.

The question suggests itself whether, under any conditions of pressure and temperature, the double line of the nitrogen-spectrum becomes single; and further, if this should be found to be the case, whether the line becomes single by the fading out of its more refrangible component, or in what other way the single line comes to occupy the position in the spectrum, not of the middle of the double line, but that of the less refrangible of the lines.

I stated in my former paper that when for any reason the light from the luminous nitrogen is greatly reduced in intensity, the double line under consideration is the last to disappear, and consequently a state of things may be found in which the light of nitrogen is sensibly monochromatic when examined with a narrow slit.† Under these circumstances the line of nitrogen appears narrower, and the separate components can be detected with difficulty, if at all.

I stated also that the breadth of the component lines appears to be connected with the conditions of density and temperature of the gas. As was to be expected from theoretical considerations, the lines become narrower and less nebulous as the pressure is diminished. My observations of this change seemed to show that the diminution of the breadth of the lines takes place chiefly at the outer sides of the lines, so that in the light from very rarefied gas the double line is narrower, but the space of separation between the components is not as much wider as would be the case if the lines had equally decreased in width on the sides towards each other.

When the pressure of the gas is reduced to about 15 inches of mercury, the line spectrum fades out to give place to Plücker's spectrum of the first order. During this process a state of things occurs when, for reasons already stated, the spectrum becomes *sensibly* monochromatic when viewed with a narrow slit and a spectroscope of several prisms. The line is narrower, and remains double, and has the characters described in the preceding paragraph.

As the pressure is diminished, the double line fades out entirely, and the spectrum of the second order gives place to the spectrum of the first order. When, however, the pressure becomes exceedingly small, from 0·1 inch to 0·05 inch, or less, of mercury, there is a condition of the discharge in which the line again appears, while the other lines remain very faint. Under these conditions I have always been able, though with some difficulty on account of the faint light when the necessary dispersive power (spectroscope B with second or third eye-piece) and a narrow slit are used, to see the line to be double, but it is narrower than when the gas is more dense, and may be easily mistaken for a single line. I have not yet been able to find a condition of luminous nitrogen in which the line has the same characters as those presented by the line in the nebula, where it is single and of the width of the slit.

Upon the whole I am still inclined to regard the line in the nebula as probably due to nitrogen.

If this should be found to be the case, and that the nebular line has originally the refrangibility of the middle of the double line of nitrogen, then we should have evidence that the nebula is moving from the earth. The amount of displacement of the nebular line from the middle of the nitrogen double line corresponds to a velocity of 55 miles per second from the earth. At the time of observation the part of the earth's orbital motion, which was from the nebula, was 14·9 miles per second. From the remaining 40 miles per second would have to be deducted the probable motion from the nebula due to the motion of the solar system in space. This estimation of the possible motion of the nebula can be regarded as only approximate.

If the want of accordance of the line in the nebula with the middle of the double line of nitrogen be due to a recession of the nebula in the line of sight, there should be a corresponding displacement of the third line as compared with that of hydrogen. For reasons which will be found in a subsequent paragraph, I have not been able to make this comparison with the necessary accuracy.

In my former paper* I gave reasons against supposing so large a motion in the nebula; these were based on the circumstance that the nebular line falls upon the double nitrogen line, which the present observations confirm. I was not then able to use a slit sufficiently narrow to show that the nebular line is single and not coincident with the middle of the double line of nitrogen.

I am still pursuing the investigation of the parts of this inquiry which remain unsettled.

Second line.—This line was found by my former comparison to be a little less refrangible than a strong line in the spectrum of barium. Three sets of measures give for this line a wave-length of 4,957 on Angström's scale; this would show that the line agrees nearly in position with a strong line of iron. At present I am not able to suggest to what substance this line belongs.

This line is also narrow and defined. I suspect that the brightness of this line relatively to the first line varies in different nebulæ.

Third and fourth line.—My former observations show that these lines agree in position with two lines of the spectrum of hydrogen, that at F and the line near G.

These lines are very narrow, and are defined; the hydrogen, therefore, must be at a low tension.

The brightness of these lines relatively to the first and second lines varies considerably in different nebulæ; and I suspect they may also vary in the same nebulæ at different times, and even in different parts of the same nebula, but at present I have not sufficient evidence on these points.† I regret that, in consequence of a continuance of bad weather, I have not yet been able to obtain decisive observations as to the possible motion of the nebula in the line of sight. With spectroscope B and eye-

* The fourth line was first seen in nebula 18 H. IV. (Phil. Trans. 1864, p. 441).

† Phil. Trans. 1868, pp. 540-546. Observations on this point were subsequently made by Frankland and Lockyer (Proc. Roy. Soc. vol. xvii. p. 453). It should be stated that they make no reference to my observations, though they refer to a purely hypothetical suggestion contained in the same paper.

* Phil. Trans. 1868, pp 542, 543.

† Since writing this sentence I have s en a note by Prof. D'Arrese in the "Astronomische Nachrichten," No. 1,885. Speaking of the nebula H. IV. 37, he says:—"Sein Spectrum ist ausser von Huggins bisher nur noch von Dr. H. Vogel untersucht worden. In No. 1,864, Ast. Nachr. theilt Letzterer mit, trotz er im Jahre 1871, im Widerspruch mit Huggins' Angabe, die Linie Neb. (3) = (2), bisweilen sogar (2) < (3) gefunden haben. Auch Huggins war dagegen im Jahre 1864 positiv (2) > (3). Ist Vögel's Beobachtung, wie ich nicht bezweifle, zuverlässig, so wird seine Vermuthung einer Veränderung hier in der That begründet sein, denn diesen Winter, namentlich im

piece 2, the lines appear to be coincident with those of hydrogen. In consequence of the uncertainty of the character of the first line, which is single, while that of nitrogen is double, this determination can now only be made by means of the comparison of the third line with that of hydrogen. This third line becomes very faint from the great loss of light unavoidable in a spectroscope that gives a sufficient dispersive power, and the comparison can only be attempted when the sky is very clear and the nebula near the meridian.

2. *On the Motions of some Stars towards or from the Earth*

In the early part of 1868 I had the honour of presenting to the Royal Society some observations on a small change of refrangibility which I had observed in a line in the spectrum of Sirius as compared with a line of hydrogen, from which it appeared that the star was moving from the earth with a velocity of about twenty-five miles per second, if the probable advance of the sun in space be taken into account.*

It is only within the last few months that I have found myself in possession of the necessary instrumental means to resume this inquiry, and since this time the prevalence of bad weather has left but few nights sufficiently fine for these delicate observations.

Some time was occupied in obtaining a perfectly trustworthy method of comparison of the spectra of stars with those of terrestrial substances, and it was not until I had arranged the spark within the tube, as described at the beginning of this note, that I felt confidence in the results of my observations.

It may be well to state some circumstances connected with these comparisons which necessarily make the numerical estimations given further on less accurate than I could wish. Even when spectroscope C, containing four compound prisms, and a magnifying power of 16 diameters are used, the amount of the change of refrangibility to be observed appears very small. The probable error of these estimations is therefore large, as a shift corresponding to five miles per second (about $\frac{1}{40}$ of the distance of D^1 to D^2), or even a somewhat greater velocity, could not be certainly observed. The difficulty arising from the apparent smallness of the change of refrangibility is greatly increased by some other circumstances. The star's light is faint when a narrow slit is used, and the lines, except on very fine nights, cannot be steadily seen, in consequence of the movements in our atmosphere. Further, when the slit is narrow, the clock's motion is not uniform enough to keep the spectrum steadily in view; for these reasons I found it necessary to adopt the method of estimation by comparing the shift with a wire of known thickness, or with the interval between a pair of close lines. I found that, under the circumstances, the use of a micrometer would have given the appearance only of greater accuracy. I wish it therefore to be understood that I regard the following estimations as provisional, as I hope, by means of apparatus now being constructed, to be able to get more accurate determinations of the velocity of rhe motions.

Sirius.—The comparison of the line at F with the corresponding line of hydrogen was made on several nights from January 18 to March 5. Spectroscope C and eye-pieces 2 and 3 were used. These observations confirm the conclusion arrived at in my former paper, that the star is moving from the earth; but they ascribe to the star a velocity smaller than that which I then obtained.

These observations on different days show a change of refrangibility corresponding to a velocity of from twenty-six miles to thirty-six miles per second. She part of the earth's orbital motion from the star varied on these days from ten miles to fourteen miles per second. We may take, therefore, eighteen to twenty-two miles per second as due to the star.

The difference of this estimate, which is probably below rather than in excess of the true current from that which I formerly made, may be due in part or entirely to the less perfect instruments then at my command. At the same time, if Sirius be moving in an elliptic orbit, as suggested by Dr. Peters, that part of the star's proper motion, which is then in the direction of the vesical ray, would constantly vary.*

Betelgeux (*α Orionis*).—In the early observations of Dr. Miller and myself on this star, we found that there are no strong lines coincident with the hydrogen lines at C and F. The line H α falls on the less refrangible side of a group of strong lines, and H β occurs in the space between two groups of strong lines, where the lines are faint. On one night of unusual steadiness in the air, when the finer lines in the star's spectrum were seen with more than ordinary distinctness, I was able with the more powerful instruments now at my command to see a narrow defined line in the red apparently coincident with H α, and a similar line at the position of H β. These lines are much less intense than the lines C and F in the solar spectrum; there are certainly no bright lines in the star's spectrum at these places.

The most suitable lines in this star for comparison with terrestrial substances for ascertaining the star's motion are the lines of sodium and of magnesium. The double character of the one line agreeing exactly with that of sodium, and the further circumstance that the more refrangible of the lines is the stronger one, as is the case in spectrum of sodium and in the solar spectrum, and the relative distances from each other and comparative brightness of the three lines, which correspond precisely to the triple group of magnesium, can allow of doubt that these lines in the star are really produced by the vapours of these substances existing there, and that we may therefore safely take any small displacement of either set of lines to show a motion of the star towards or from the earth. The lines due to sodium are perhaps more intense, but are as narrow and defined as the lines D_1, D_2 in the solar spectrum; they fall, however, within a group of very fine lines; this circumstance may possibly account for the nebulous character which has been assigned to them by Father Secchi.

The bright lines of sodium were compared with spectroscope B and eye-piece 3; they appeared to fall very slightly above the pair in the star, showing that the stellar lines had been degraded by the star's motion from the earth. The amount of displacement was estimated at about one-fifth of the distance of D_1 from D_2, which is probably rather smaller than the true amount. This estimation would give a velocity of separation of thirty-seven miles per second. At the time of observation the earth was moving from the star at about fifteen miles per second, leaving twenty-two miles to be due to the star.

When magnesium was compared, a shift in the elevation, and corresponding in extent to about the same velocity of recession, was observed; but in consequence of other lines in the star at this place, the former estimation, based on the displacement of the lines of sodium, was considered to be more satisfactory.†

Rigel.—The lines of hydrogen are strong in the spectrum of this star, and are suitable for comparison.

The line of H β is not so broad as it appears in the speculum of Sirius, but is stronger than F in the solar spectrum: this line was compared by means of spectroscope C and eye-pieces 2 and 3. The line of terrestrial hydrogen falls above the middle of the line in the star; the star is therefore receding from the earth. The velocity of recession may be estimated as rather smaller than Sirius, probably about thirty miles per second, the earth at the time of observation moving from the star with a velocity of fifteen miles, leaving about fifteen miles as due to the star. This estimate is probably rather smaller than the true velocity of the star.

Februar und März 1872, fand ich wiederum, so wie es Huggins früher gesehen hat, unzweifelhaft (2) > (3). Die relative Intensität der drei Lichtarten habe ich mehrfach in Zahlen geschätzt und erhielt z. B. in den letzten Nächten:

	März 6.	März 13.
(1)	100	100
(2)	58	63
(3)	49	52

* Phil. Trans. 1868, pp. 529-550. As a curious instance in which later methods of observations have been partially anticipated, a reference may be made to an ingenious paper in the Philosophical Transactions for 1783, vol. lxxiv., by the Rev. John Mitchell, entitled "On the means of discovering the Distance, Magnitude, &c., of the Fixed Stars, in consequence of the Diminution of the Velocity of their Light." The author suggests that by the use of a prism "we might be able to discover diminutions in the velocity of light as perhaps a hundredth, a two hundredth, a five hundredth, one even thousandth part of the whole." But he then goes on to reason on the production of this diminished velocity by the attraction produced on the material particles of light by the matter of the stars, and that the diminutions stated above would be "occasioned by spheres whose diameter should be to the sun, provided they were of the same density, in the several proportions of 70, 50, 30, and to 22 to 1 respectively."

* H. Vögel at Bothkamp seems to have repeated my observations on Sirius with the necessary care. He says (Astron. Nachr. No. 1864):—"Mit der eben beschriebenen Anordnung gelang es Herrn Dr. Lohse und mir am 22 März (1871) bei ganz vorzüglicher Luft die Nichtcoincidenz der drei Wasserstofflinien H α, H β, und H γ, der Geissler'schen Rohre mit den entsprechenden Linien des Siriusspectrums zu sehen...... mit Berücksichtigung der Geschwindigkeit der Erde zur Zeit der Beobachtung berechnet sich die Geschwindigkeit mit welcher sich Sirius von der Erde bewegt zu 10·0 Meilen in der Secunde, wogegen Procyon sich 13·8 Meilen in der Secunde von unserer Erde entfernen würde."

† I had the pleasure on one evening of showing the displacement of the lines in Sirius and α Orionis to Mr. Christie, First Assistant at the Greenwich Observatory.

Castor.—The spectra of the two component stars of this double star blend in the spectroscope into one spectrum. The line H β is rather broad, nearly as much so as the same line in the spectrum of Sirius.

The narrow line of rarefied hydrogen was compared in spectroscope B with eye-piece 3; it appeared to fall on the more refrangible side of the middle of the line in the star, leaving more of the dark line on the side towards the red. The shift seemed to be rather greater than that in Sirius, and may probably be taken at from 40 to 45 miles per second; but the earth's orbital motion was nearly 17 from the star, thus leaving about 25 miles for the apparent velocity of the star. This result rests at present on observations on one night only, but they seemed at the time to be satisfactory.

Regulus.—The line at F rather broad. The corresponding line of hydrogen falls on the more refrangible side of the middle of the dark line in the star. The air was unfavourable on all the evenings of comparison; a rough estimate gives a velocity of from 12 to 17 miles for the velocity of recession between the star and the sun.

β and δ Leonis.—These stars were compared with hydrogen; they appear to be moving from the earth, but the want of steadiness in the air prevented me from making a satisfactory estimate of their velocity. I suspected their motion to be smaller than that of Regulus.

β, γ, δ, ε, ζ Ursæ Majoris.—All these stars have similar spectra, in which the line F is strong, though there are small differences in the breadth of the line. They were compared with hydrogen, and appear to be moving from our system with about the same velocity. Probably their motion may be taken to be not far from 30 miles per second. The earth's motion at the time of observation was from 9 miles to 13 miles for these stars, leaving a probable velocity of recession of 17 to 20 miles per second. In the case of the double star ζ, the spectrum consisted of the light of both stars.

η Ursæ Majoris was also compared with hydrogen. I believe it shows a motion from the earth, but the observations of this star are at present less satisfactory.

α Virginis and α Coronæ Borealis.—These stars were compared with hydrogen. I suspect that they are receding, but I have not had nights sufficiently fine to enable me to make satisfactory observations of these stars.

In addition to these stars some observations (which are less satisfactory on account of the unfavourable state of the weather at the time) appear to show that the stars Procyon, Capella, and possibly Aldebaran, are moving from the earth.

The stars which follow have a motion of approach.

Arcturus.—In the spectrum of this star the lines of hydrogen, of magnesium, and of sodium are sufficiently distinct for comparison. I found the comparison could be most satisfactorily made with magnesium.

The bright lines of magnesium fall on the less refrangible side of the corresponding dark lines in the star's spectrum, showing that the star is approaching the earth. I estimated the shift at about $\frac{1}{6}$ to $\frac{1}{4}$ of the interval between Mg_2 and Mg_3; this amount of displacement would indicate a velocity of approach of 50 miles per second. To this velocity must be added the earth's orbital motion from the star of 5·25 miles per second, increasing the star's motion to 55 miles per second.

When I can get favourable weather, I hope to obtain independent estimations from the lines of sodium and of hydrogen.

α Lyræ.—In the spectrum of Vega the line corresponding to H β is strong and broad. Comparisons were made on several nights, but on one evening only was the air favourable. The observations are accordant in showing that the narrow bright line from a Geissler's tube falls on the less refrangible side of the middle of the line in the star, thus leaving more of the line on the side towards the violet. The estimations give a motion of approach between the earth and the star of from 40 to 50 miles per second, to which must be added 3·9 miles after the earth's motion from the star.

α Cygni.—The hydrogen line at F in the spectrum of this star is narrower than in the spectrum of Sirius and of α Lyræ, though probably rather broader than the same line in the solar spectrum. I have at present observations made on two evenings only, on both of which the state of the air was unfavourable, of the comparison of this line with that of terrestrial hydrogen. They give to the star a motion of approach of about 30 miles per second, which would have to be increased by 9 miles, the velocity at the time of the earth from the star.

Pollux.—The lines of magnesium and those of sodium are very distinct in the spectrum of this star. As the air was not very steady at the time of my observations, I found it more satisfactory to use for comparison the lines of magnesium, which are rather stronger than those of sodium. The three lines of magnesium appeared to be less refrangible than the corresponding dark lines in the spectrum of the star by about one-sixth of the interval from Mg_2 to Mg_3. This estimation would represent a velocity of approach equal to about 32 miles per second. The earth's motion from the star was 17·5 miles, which increases the apparent velocity of approach to 49 miles per second. On one evening only was the air favourable enough for a numerical estimate, but the observations were entered in my observatory-book as very satisfactory.

α Ursæ Majoris.—The spectrum of this star is very different from the spectra of the other bright stars of this constellation. The line at F is not so strong, while the lines at *b* are more distinct, and are sufficiently strong for comparison with the bright lines of magnesium. The bright lines of this metal fall on the less refrangible side of the dark lines, and show a motion of approach of from 35 to 50 miles per second. The earth's motion of 11·8 miles from the star must be allowed for.

γ Leonis and ε Bootis.—In both these double stars the compared spectrum due to the light of both important stars were observed. Both stars are most conveniently compared with magnesium. I do not consider my observations of these stars as quite satisfactory, but they seem to show a movement of approach; but further observations are desirable.

The stars *γ Cygni*, *α Pegasi*, *γ Pegasi*, and *α Andromedæ* were compared with hydrogen on one night only. It is probable that these stars are approaching the earth, but I wish to re-observe them before any numerical estimate is given of their motion.

γ Cassiopeiæ—On two nights I compared the bright lines which are present in its spectrum at C and F with the bright lines of terrestrial hydrogen. The coincidence appeared nearly perfect in spectroscope C with eye-pieces 2 and 3; but on the night of least definition I suspected a minute displacement of the bright line towards the red when compared with H β. As the earth's orbital motion from the star at the time was very small, about 3·25 miles per second, which corresponds to a shift that could not be detected in the spectroscope, it seems probable that γ Cassiopeiæ has a small motion of recession.

In the calculation of the estimated velocities the wave-lengths employed are those given by Angström in his "Recherches sur le spectre solaire," Upsal, 1868. The velocity of light was taken at 185,000 miles per second.

The velocities of approach and of recession which have been assigned to the stars in this paper represent the whole of the motion in the line of sight which exists between them and the sun. As we know that the sun is moving in space, a certain part of these observed velocities must be due to the solar motion. I have not attempted to make this correction, because, though the direction of the sun's motion seems to be satisfactorily ascertained, any estimate that can be made at present of the actual velocity with which he is advancing must rest upon suppositions, more or less arbitrary, of the average distance of stars of different magnitudes. It seems not improbable that this part of the stars' motions may be larger than would result from Otto Struve's calculations, which give, on the supposition that the average parallax of a star of the first magnitude is equal to 0″·209, a velocity but little greater than one-fourth of the earth's annual motion in its orbit.

It will be observed that, speaking generally, the stars which the spectroscope shows to be moving from the earth (Sirius, Betelgeux, Rigel, Procyon) are situated in a part of the heavens opposite to Hercules, towards which the sun is advancing; while the stars in the neighbourhood of this region, as Arcturus, Vega, α Cygni, show a motion of approach. There are in the stars already observed exceptions to this general statement; and there are some other considerations which appear to show that the sun's motion in space is not the only, or even in all cases, as it may be found, the chief cause of the observed proper motions of the stars.

There can be little doubt but that in the observed stellar movements we have to do with two other independent motions, namely, a movement common to certain groups of stars, and also a motion peculiar to each star.

Mr. Proctor has brought to light strong evidence in favour of the drift of stars in groups having a community of motion, by his graphical investigation of the proper motions of all the stars in the catalogues of Mr. Main and Mr. Stone.* The probability of the stars being collected into such systems was early suggested by Mitchell and the elder Herschel.† One of the most remarkable instances pointed out by Mr. Proctor are the stars β, γ, δ, ε of the Great Bear, which have a community of proper motions.‡ while α and η of the same constellation have a proper motion in the opposite direction. Now, the spectroscopic observations show that the stars β, γ, δ, ε, ζ have also a common motion of recession while the star α is approaching the earth. The star η indeed appears to be moving from us, but it is too far from α to be regarded as a companion to that star.

TABLE I.—Stars moving from Sun

Star.	Compared with	Apparent motion.	Earth's motion.	Motion from sun.
Sirius . . .	H	26 to 36	—10 to 14	18 to 22
Betelgeux . .	Na	37	—15	22
Rigel . . .	H	30	—15	15
Castor . . .	H	40 to 45	—17	23 to 28
Regulus. . .	H	30 to 35	—18	12 to 17
β Ursæ Maj. .	H			
γ " " .	H			
δ " " .	H	30	— 9 to 13	17 to 21
ε " " .	H			
ζ " " .	H			
β Leonis . .	H			
δ Leonis . .	H			
η Ursæ Maj. .	H			
α Virginis . .	H			
α Coronæ B. .	H			
Procyon . .	H			
Capella. . .	H			
Aldebaran ? .	Mg			
γ Cassiopeiæ .	H			

TABLE II.—Stars approaching the Sun

Star.	Compared with	Apparent motion.	Earth's motion.	Motion towards sun.
Arcturus . .	Mg	50	+ 5	55
Vega . . .	H	40 to 50	+39	44 to 54
α Cygni. . .	H	30	+ 9	39
Pollux . . .	Mg	32	+17	49
α Ursæ Maj. .	Mg	35 to 50	+11	46 to 60
γ Leonis . .	Mg			
ε Bootis. . .	Mg			
γ Cygni. . .	H			
α Pegasi . .	H			
γ Pegasi ? . .	H			
α Andromedæ.	H			

Although it was not to be expected that a concurrence would always be found between the proper motions which indicate the apparent motions at right angles to the line of sight and the radial motions as discovered by the spectroscope, still it is interesting to remark that in the case of the stars Castor and Pollux, one of which is approaching and the other receding, their proper motions also are different in direction and in amount; and further, that γ Leonis, which has an opposite radial motion to α and β of the same constellation, differs from these stars in the direction of its proper motion.

* See "Preliminary Paper on certain Drifting Motions of Stars," Proc. Roy. Soc vol. xviii, p. 169.

† Sir William Herschel writes:—"Mr. Mitchell's admirable idea of the stars being collected into systems appears to be extremely well founded, and is every day more confirmed by observations, though this does not take away the probability of many stars being still as it were solitary, or, if I may use the expression, intersystematical. . . A star, or sun such as ours, may have a proper motion within its own system of stars; while at the same time the whole starry system to which it belongs may have another proper motion totally different in quantity and direction." Herschel further says, "and should there be found in any particular part of the heavens a concurrence of proper motions of quite a different direction, we shall then begin to form some conjectures which stars may possibly belong to ours, and which to other systems."—Phil. Trans. 1783, pp. 276, 277.

‡ Mr. Proctor, speaking of these stars, says:—"Their drift is, I think, most significant. If, in truth, the parallelism and equality of motion are to be regarded as accidental, the coincidence is one of most remarkable character. But such an interpretation can hardly be looked upon as admissible when we remember that the peculiarity is only one of a series of instances, some of which are scarcely less striking."—"Other Worlds than Ours," p. 269, and paper in Proc. Roy. Soc. vol. xviii. p. 170.

It scarcely needs remark that the difference in breadth of the line H β in different stars affords us information of the difference of density of the gas by which the lines of absorption are produced. A discussion of the observations in reference to this point, and to other considerations on the physical condition of the stars and nebulæ, I prefer to reserve for the present.

EXCURSION OF THE GEOLOGISTS' ASSOCIATION TO GUILDFORD AND CHILWORTH, JUNE 1

THE party first proceeded to examine the section of the "Woolwich and Reading Beds," just north of the station. This section was described by Mr. Prestwich in 1850 (see Quarterly Journal Geological Society, vol. vi. p. 260, fig. 6) not long after it had been exposed by the railway-cutting. A year ago it was laid bare afresh when widening the railroad; but already the slipping of the clays has obliterated some points of interest. Traces of the shell beds, with *Cyrena* and *Ostrea*, below the representatives of the "Oldhaven beds," are to be found at the base of a telegraph post, 104 yards south of the road bridge; and the underlying mottled clays, with a dip of 4° to the north, are easily recognised for about 190 yards to the south, where a small valley (about 50 yards across) has been formed by denudation out of the sand and lowest green sandy clays resting on the Chalk, which forms the northern foot of the Hogsback or Surrey range. Here the Chalk is seen to be traversed in every direction with fissures, often "slickensided," horizontally or nearly so, some empty, some filled with vein flint, and some with loamy stuff. Nodules and occasional thin laminæ of flint follow the dip of about 6° to the north, and many are in a crushed condition. Bands of marly chalk also lie on the same plane. Some Echinoderms were met with. The party then proceeded to visit the much larger excavation in the Chalk at the entrance of the railway tunnel. Here the dip, well marked by flints and marly bands, is about 12° to the north. Fossils (Sponges, Echinoderms, Inoceramus, &c.) abound in this pit. The usual chalcedonic and quartzy interiors of hollow flints attracted notice, and Prof. R. Jones drew attention to facts that seemed to him to bear evidence of flint being a pseudomorph after chalk. They next visited a quarry in the Lower Greensand, on the escarpment overlooking the pathway to Losely. In this section of those Neocomian beds known as the Bargate Stone, the waterworn sand of quartz, ironstone, lydite, and hard green silicates, is so largely mixed with calcareous fragments (the *débris* of shell beds, polyzoan reefs, &c.) that it is here and there cemented together hard and compact enough to serve as a building stone and road-metal. Mr. Meyer here directed attention to the horizon at which he obtained an unrolled tooth of *Iguanodon*, indicating the existence of this great Dinosaur at, perhaps, the latest period to which any of its remains as yet known belong. The "false-bedding" of the sands—due to the southward set of prevalent tides and currents, and the probable origin of their materials from the "old palæozoic ridge or shoal," were also studied, and the formation of the escarpment, with the correlative parallel cracks and fissures of the strata. The party then crossed the Ferry, where St. Catherine's Spring issues, beneath the hill, from a little cave in the red-orange-tinted sand. Here for thirty feet at least the Guildford gap has been found by boring to be occupied by bouldered chalk and other detritus due to the destructive, and yet conservative, agencies of nature. The soft irony beds of the Lower Greensand were next met with, and followed followed for about a mile, until a short field-lane, crossing the Gault and Upper Greensand, led into the Chalk-marl quarry below Warren Farm. Here the loss of the clay beds (Gault) from below, by their having been squeezed out along the southern side, had allowed the hard marl-rock to subside inwards and suddenly at the escarpment, and to rest at high angle (70° and more), whilst the Chalk of the hill range above dips only 5° or 6°. As the hard rock bands, here quarried for lime, are followed end-on along the strike (open to-day), the backs of lower beds form one side of this deep narrow pit; and the truncated edges of these somewhat bent and much fissured strata warn the instructed eye of the danger of standing either below them or above them, lest either rain or drought should detach their clinging surfaces from the sloping bed-plane. Large Ammonites and Nautili are the chief fossils met with here; but *Pecten Beaveri* and *Terebratula* are also found. In an old excavation in the lane *Siphonia* has been found in the representative of the Upper Greensand which is overlain by dark-green sandy clay and Gault, turned up at a high angle (and probably squeezed out) in the breadth of a few yards, before the iron-sands are reached on returning to the hill-side. The party next came to the foot of St. Martha's Hill, or Martyrs' Hill. Before mounting this hill of sand, seamed irregularly with ironstone, some of the geologists descended the Halfpenny Hatch lane, leading down towards the East Shalford bottom, and saw a section of sand and calcareous sandstone, with a fuller's earth band and pebbly beds, similar to those in the quarry on the other (western) side of Guildford. The underground structure of South-Eastern England is connected with that of the Boulonnais, of Belgium, the Ardennes, and Westphalia; and the folds and ridges of palæozoic rocks, that in those countries bear up, either at the surface or just beneath the Chalk, or the attenuated Oolites, valuable coal-beds, are continued through, in a broad sweeping line, underneath parts of Surrey, Kent, and Sussex, until visible again near Frome, in the Bristol coal-area, in North Devon, South Wales, and the South of Ireland. The old faults and fissures affecting this linear tract of old strata had long before the Coal-period raised and depressed the lands and sea-beds; and, as a great spur of the old Scandinavian lands, this tract afforded ground for the littoral growth of the jungles that formed the coal on its oscillating borders and in its lagoons, now shut up by bars, and now losing their marsh features by influx of the sea. Succeeding ages still brought oscillations and changes, until the Jurassic seas crept over this old ridge or shoal, and the Cretaceous seas quite buried it, at first in sands and ultimately by the calcareous ooze of oceanic depths. But again another contracting crush of the earth's crust operated on the old weak lines, and the buried ridge slowly uprose, and its coating of thick strata were worn off by sea and rain, making pebbles and sand for the Lower Tertiaries; and still rising, it was at length laid bare in the Franco-Belgian and the Bristol areas; whilst our Wealden valleys of elevation, and those of Kingsclere, Shalbourn, and Pewsey, show where its uneven back approaches near the soil.

SOCIETIES AND ACADEMIES

London

Royal Society, June 20.—"On the 26-day Period of the Earth's Magnetic Force," by Mr. J. A. Broun, F.R.S.

Referring to the Astronomer Royal's important communication on this subject, the author confesses that, projecting his results for the horizontal force, he cannot agree in his final conclusions from them. In his paper he limits himself wholly to the observations of the horizontal force, as he has found that element, when aecurately corrected for temperature, best fitted to show the period in question.

As far as the existence of a period of near 26 days is concerned, he thinks there cannot be the slightest doubt; the examination of great masses of observations has confirmed his belief; but we know nothing certainly as to its cause. It appears to be most probably connected with the sun's rotation; but in what way this may act nothing is known. The single periods show great breaks, and what may be termed *accidental* minima, in opposition to the minima belonging to the period; these accidental are connected with great disturbance, probably allied to the solar erruptions, or to causes which generally produce spots and protuberances. We might suppose that the sun during its rotation produces an action on the magnetic or electric ether in motion, which, as far as it acts on our magnet, may be supposed in greater quantity or more condensed in certain parts of the earth's orbit, and in certain years; and, as has been supposed in the case of the frequency of the solar spots, this ether may also be acted on by the planet, and produce an irregularity in the length of a few successive periods. These suppositions are made merely to show that we are perhaps not in possession of all the conditions of the problem, without which perfect exactness in the calculations is impossible.

In conclusion, he refers those interested in the subject to plate xxvii. in the Transactions of the Royal Society of Edinburgh, vol. xxii. where the daily means of horizontal force are projected for four stations on the earth's surface, all of which agree in showing the same movements, some of which have an amplitude of ·002 of the whole horizontal force (the Astronomer Royal's result for 1870 gives a *mean* value of nearly the half of this), and with intervals of about 26 days.

Paris

Academy of Sciences, July 1.—M. M. Marie read a memoir on some general properties of the imaginary envelope of the conjugates of a plane place.—M. H. Resal communicated general equations of the movements of a solid body referred to its movable axes; and M. Montucci forwarded a note describing an experiment for the appreciation of the resistance of a sheet of brass to atmospheric pressure.—M. J. Bourget presented a memoir on the mathematical theory of the movement of a cord, one of the extremities of which possesses a given movement.—M. G. Tissandier communicated a notice of an optical phenomenon observed during a balloon ascent, describing a case in which the shadow of the balloon was thrown distinctly upon a white cloud, and surrounded by a pale elliptical halo, exhibiting the colours of the rainbow. — M. Faye communicated a letter from M. Tacchini noticing the occurrence of magnesium in the chromosphere of the sun.—M. J. A. Brown presented a note on the simultaneity of barometric variations between the tropics.—General Morin communicated an extract from a letter by M. Vinson describing a severe cyclone which followed the aurora australis of Feb. 4, 1872, at Reunion.—M. W. de Fonvielle gave an account of observations made during the ascents of the balloon "Lea," in which he refers to the above-mentioned note by M. Tissandier, giving the credit of the first observation of the halo round the shadow of balloons to Mr. Glaisher, and especially to the oscillation and rotation of balloons.—M. L. Sollier forwarded a note on the destruction of *Phylloxera vastatrix* by means of a decoction of tobacco.—M. C. Bernard presented a fourth note by M. Paul Bert, on the influence exerted by changes of barometric pressure upon the phenomena of life; and M. Wurtz communicated a third note, by M. Oré, on the question whether strychnine is to be regarded as an antidote to chloral.—M. Decaisne communicated an interesting paper by MM. Van Tieghem and Le Monnier, "On the Polymorphism of the Reproductive Organs in the mucorine genus *Mortierella*."—M. Leymerie presented a brief reply to a note by M. Garrigou on the constitution of the Pyrenees.

BOOKS RECEIVED

English.—Town Geology: Rev. C. Kingsley (Strahan and Co.).—The Life of Richard Trevithick, vol. i.: F. Trevithick (E. and F. Spon).—Health and Comfort in House Building: J. Drysdale and J. W. Hayward (E. and F. Spon).—Nautical Surveying: J. K. Laughton (Longmans).—Sewer Gas, and how to keep it out of Houses: O. Reynolds (Macmillan).

Foreign.—Zeitschrift für Biologie: Pettenkofer, Radlkofer, and Vogt, Band 7, Heft 3, 4, Band 8, Heft 1.—Abhandlungen des Naturwissenschaftlichen Vereins zu Bremen, Band 3, Heft 1.—Die Echinoiden der oesterreichisch-hungarischen oberen Tertiärablagerungen: Dr. Laube.—Die Erforschung des Süden-polar Gebietes: Dr. G. Neumayer.—Zur Kenntniss der Chlorophyllfarbestoffe: Dr. G. Kraus.—Jahrbuch der k. k. geologischen Reichsanstalt zu Wien, Jan.-March.—Notizblatt des Vereins für Erdkunde: L. Ewald.—Zur Morphologie des Säugethier-Schädels: Dr. J. C. G. Lucae.

CONTENTS

Errata.—Vol. v., p. 167, col. 8, l. 20, for "sufficient from" read "sufficient heat from;" p. 168, col. 1, l. 11, for "inorganic" read "organic."