THURSDAY, SEPTEMBER 14, 1871

THE ANCIENT GEOGRAPHY OF INDIA

The Ancient Geography of India. I. The Buddhist Period, including the Campaigns of Alexander, and the Travels of Hwen-Thsang. By Alexander Cunningham, Major-General, R.E. With thirteen maps. (London: Trübner and Co., 1871.)

THE principal difficulty in the study of Indian antiquities has always been the absence of a chronological framework. The Indians themselves had no idea of what we mean by history. They possessed a vague regard for antiquity, but for an antiquity measured by millions of years; while an attempt to find out whether a certain event had happened fifty or a hundred years sooner or later, seemed to possess in their eyes no interest whatever. The result has been that even at present, after Sanskrit literature has been studied for nearly a hundred years, we are still completely in the dark as to the chronology of ancient Indian history. We have a date here and there, as, for instance, the date of Buddha, the great reformer, or of Pâṇini, the great grammarian; but even these are dates which rest to a certain extent on the good will of Sanskrit scholars, and which it would be difficult to defend against the attacks of uncompromising sceptics. Some people still speak of the Laws of Manu as an ancient authority dating from the eighth century B.C.; others would hesitate to assign that compilation in its present form to an ante-Christian era. The dates of the Mahâbhârata and Râmâyaṇa, the two great epic poems, the dates again of the six systems of Hindu philosophy, are equally uncertain, and the Purâṇas which were at one time quoted as co-equal with the most ancient literary monuments of the world, are now assigned to the age of Charlemagne rather than to that of Moses.

It may easily be imagined therefore how gratefully Sanskrit scholars would receive any kind of authentic information that should enable them to draw a line somewhere, and to vindicate for certain events and certain works of literature a date that could no longer be called in question. The contact between India and Alexander the Great enabled scholars to fix the date of King Ḳandragupta as the contemporary of Alexander, and through him the date of another king, Aśoka, who had raised Buddhism to be the state religion of his realm, and had left besides some important inscriptions which we possess, and which are written in a language that is no longer Sanskrit. Unfortunately the Greek accounts of India are so meagre that they did not yield much help for determining the literary state of India, and it is a curious fact that no native writer ever mentioned the name of Alexander as the invader of India.

The next contact between India and the outer world was through Buddhism. Buddhism was a proselytising religion, and even before the beginning of the Christian era Buddhist missionaries had reached Tibet and China to preach there the doctrines of Buddha. Thus it happened that after Buddhism had been established in China, pilgrims from that country travelled to India as the Holy Land of their religion, and spent years in the country collecting relics and manuscripts, and learning the language in which the sacred books of Buddhism were written.* Some of them wrote descriptions of their travels in India, and the two most important of them, the travels of Fa-hian and Hiouen-thsang, have been preserved. It is true that Fa-hian belongs to the beginning of the fifth century A.D., while Hiouen-thsang travelled through India from 629 to 645. But even such late witnesses were not to be despised, and it is well known that the publication of Hiouen-thsang's travels by M. Stanislas Julien marked quite a new epoch in the history of Sanskrit scholarship. Here was at all events *terra firma* where historians might take their stand to look forward and backward. Cities which he had visited, buildings which he had described, kings whom he had seen, books which he had read, stood out like landmarks in the desert of Indian history; and though their date might hereafter have to be fixed as much anterior to Hiouen-thsang or Fa-hian, yet it was something to be convinced of their historical reality even at the late date of these Chinese travellers. With regard to the history of Sanskrit literature, the gain was less considerable than might have been expected, for although both Fa-hian and Hiouen-thsang learned Sanskrit, they learned it for the sake of Buddhist literature only, and cared but little for the ancient literature of the Brahmans. Yet from time to time we gain a few valuable grains. We must not forget that the time when the whole of Sanskrit literature was regarded as a forgery and the ancient language of India as a mere invention is not so very distant; and that the fact of a Chinese traveller of the seventh century giving a paradigm of the Sanskrit verb *bhû*, "to be," would have been extremely useful in silencing Dugald Stewart's scepticism. It is equally interesting that the Chinese pilgrim mentions at least one archaic form as peculiar to the grammar of the Veda—viz., *bhavâmasi*, "we are," instead of the common *bhavâmas*. The mention also of some technical grammatical terms, such as *tinanta*, verb, *subanta*, noun, *Unâdi*, and possibly *Nirukta*, are curious as showing that Hiouen-thsang still learned Sanskrit according to the system of Pâṇini, and not of some later grammarians.

The most important evidence, however, that could be gathered from the works of these Chinese pilgrims was geographical. M. Vivien de Saint-Martin, in France, and Prof. Lassen, in Germany, have fully availed themselves of that evidence in their works on the Geography and Antiquities of India; and General Cunningham's new work on the "Ancient Geography of India" is, in fact, a running commentary on the travels of these Chinese priests. General Cunningham's name is well known in England as an indefatigable explorer of Indian antiquities, and he brings to his task accomplishments in which few scholars could excel him. We may quote his own words:

"My own travels," the General says in his Preface, "have been very extensive throughout the length and breadth of Northern India, from Peshawer and Multan, near the Indus, to Rangoon and Prome on the Irawadi, and from Kashmir and Ladâk to the mouth of the Indus and the banks of the Narbada. Of Southern India I have seen nothing, and of Western India I have seen only Bombay, with the celebrated caves of Elephanta and Kanhari. But during a long service of more than thirty years in India, its early history and geography have formed

* "Buddhist Pilgrims," in M. M.'s "Chips from a German Workshop," vol. i. p. 236.

the chief study of my leisure hours; while, for the last four years of my residence, these subjects were my sole occupation, as I was then employed by the Government of India as archæological surveyor to examine and report upon the antiquities of the country."

General Cunningham has divided the geography of India according to the same system which is generally adopted in the history of India, viz., into the Brahmanical, the Buddhist, and the Mohammedan periods; and he has selected the second or Buddhist period as the principal subject of his first volume. The first or Brahmanical period traces the gradual extension of the Aryan race over Northern India, and comprises that early section of their history during which the religion of the Vedas was the prevalent belief of the country. The geography of that period, as far as it can be worked out from the Vedic writings, has been treated by M. Vivien de Saint-Martin, and by Prof. Lassen in his "Indische Alterthumskunde."

The second or Buddhist period embraces the rise, extension, and decline of the Buddhist faith, from the time when Buddhism became the state religion of India to the conquests of Mahmud of Ghazni. As the beginning of the political influence of Buddhism coincides in time with the invasion of India by Alexander and the subsequent establishment of Greek dynasties on the Indian frontier, the historian of this period has, in the beginning, the advantage of the Greek accounts, while further on, from 400 to 700, he has to depend mainly on the accounts furnished by Chinese pilgrims. This period, too, has been ably treated by M. Vivien de Saint-Martin in several *mémoires*, and by Prof. Lassen in his "Indische Alterthumskunde," yet there was room left for new inquiries; and the results of these inquiries have been published by General Cunningham in the volume now before us.

The third or Mohammedan period has not yet been treated as a whole, though there are ample materials for it in the works of Reinaud, Elliot, Erskine, and others.

The chief merit of General Cunningham's work consists in his description of spots of which he can speak as an eye-witness. Here his knowledge of the actual localities has enabled him either to confirm the identifications of his predecessors, or to fix by more correct evidence the real site of the places described by Greek or Chinese geographers. He furnishes himself, at the end of his Preface, a list of the more important of his own identifications. Whenever his identifications are based on local peculiarities his arguments seem always powerful and convincing. It is when he bases his views on the evidence of mere names that one feels occasionally inclined to withhold one's assent. The changes in local names are, no doubt, most capricious, and amenable to hardly any rules. Everything is possible here; but for that very reason nothing should be assumed that cannot be proved by historical evidence. Hiouen-thsang calls Ceylon *Seng-kialo*, which is the Chinese rendering of the Sanskrit name *Sinhâla*. The fuller Sanskrit name is *Sinhâla-dvîpa*. This passes through a chain of changes, all of which can be traced historically, from *Singal-dib* to *Sirandib* to *Zilan* and *Ceylon*.

These changes may seem violent; but they are not half so objectionable as, for instance, the simple change *Sâlâtura* to *Hâlâtura*, *Alâtur*, and finally to *Lahor*, proposed by General Cunningham (pp. 57, 58). It is true that the *s* of *Sindhu* is changed to *h* in *Hindu*, and afterwards elided in *India*, but the *s* of *Sindhu* is different from the palatal *s* of *Sâlâtura*. Besides, that dental *s* was changed into *h* in Persia, not in India, and dropped at last only in the mouths of Greeks, who first heard the name from the mouths of the Persians. The same objection applies to the proposed change of *Svetavâsa* into *Khetâs* (p. 125). The *sv* of *Sveta*, "white," would not become *Kh* in the western countries; it could do so only if the *s* were a dental *s*, which it is not.

Again General Cunningham admits occasionally formations of Sanskrit names, which are entirely against the genius of the language. On page 29, in explaining the name of *Begrâm*, he says:—"Masson derives the appellation from the Turki *be* or *bi*, 'chief,' and the Hindu *grâm* or 'city,' that is, the 'capital.' But a more simple derivation would be from the Sanskrit *vi*, implying 'certainty,' 'ascertainment,' as in *vijaya*, 'victory,' which is only an emphatic form of *jaya*, with the prefix *vi*. *Vigrâma* would, therefore, mean emphatically 'the city,' that is, 'the capital,' and *Bigrâm* would be the Hindu form of the name." A Sanskrit scholar would say at once that such a compound of *grâma*, "village," with the preposition *vi* is impossible. The preposition *vi* may be joined to a verb or verbal noun, like *jaya*, "victory," but not to a noun like *grâma*. I had, myself, derived the name of *Begrâm* from *bhaga-ârâma*, the abode of the god Bhaga, or of the gods in general; taking *bhaga* either in the sense of the Sun god, or like the Zend *bagha*, the old Persian *baga*, in the sense of gods in general, and *ârâma* as abode. *Bhagârâma* changed to *Begrâm* would be a sort of synonym of *Behistân*, τὸ Βαγίστανον ὄρος, the place of the *Bhagas*, or of *Bhaga*, the Lord. In this conjecture I have since been confirmed by finding that Albyruny mentioned *Bhagapura*, town of Bhaga, as one of the names of Multân (Reinaud, Mémoire, p. 98).

It is well known that the name of the Kabul river, Κώφην, occurs in the hymns of the Rig Veda as *Kubhâ*, but I cannot understand on what ground General Cunningham declares that name to be non-Aryan. The etymology of proper names is never very easy, but here would be no difficulty in connecting *Kubhâ* either with *Kumbhâ*, "vessel" Greek κύμβος or with κυφή an old Cretan word for "head" (Sk. ka-kubh), or with κυφός, "bent, crooked." *Kutilâ*, "crooked," is the name of a river, and *Kampanâ*, "the trembling," is the name of one of the rivers of Kabulistan, it may be of the Kabul river itself. As *Kubhâ*, the Kabul river, is mentioned but twice in the Rig Veda, I shall give the two passages:

Mâ vaḥ Rasâ anitabhâ Kubhâ Krumuḥ mâ vaḥ Sindhuḥ ni víramat, Mâ vaḥ pari sthât Sarayuḥ purîshiṇî asme it sumnam astu vaḥ. ("O ye Storm-gods, let not the Rasâ with infinite splendour (amitabhâ), let not the Krumu, or the Sindhu delay you; let not the misty Sarayu surround you:—with us alone be your delight!") (Rv. v. 53, 9.)

Tṛishṭâmayâ prathamam yâtave saǧûḥ Susartvâ Rasayâ Śvetyâ tyâ Tvam Sindho Kubhayâ Gomatîm Krumum Mehatnoâ karatham yabhiḥ îyase. ("First joined together with the Tṛishṭamâ for thy course, with the Susartu, the Rasâ, the Śvetî, thou O Sindhu (goest), with the Kubhâ to the Gomatî, the Krumu, with whom thou proceedest together with the Mehatnu.") Rv. x. 75, 6.

This verse is not free from difficulties, and in some parts my translation may be questioned. But it is clear in the main that the poet in praising the Sindhu (the river Indus), mentions its tributaries. The first tributaries which join the Indus before its meeting with the *Kubhâ* or the Kabul river cannot be determined. All travellers in these northern countries complain of the continual changes in the names of the rivers, and we can hardly hope to find traces of the Vedic names in existence there after the lapse of three or four thousand years. The rivers intended may be the Shauyook, Ladak, Abba Seen, and Burrindoo, but one of the four rivers, the Rasâ, has assumed an almost fabulous character in the Veda. After the Indus has joined the Kubhâ or the Kabul river, two names occur, the *Gomatî* and *Krumu*, which I believe I was the first to identify with the modern rivers the *Gomal* and *Kurrum*. (Roth, Nirukta, Erläuterungen, p 43, Anm.) The Gomal falls into the Indus, between Dera Ismael Khan and Paharpore, and although Elphinstone calls it a river only during the rainy season, Klaproth (Foe. koue ki, p. 23) describes its upper course as far more considerable, and adds: Un peu à l'est de Sirmágha, le Gomal traverse la chaîne de montagnes de Solimán, passe devant Raghzi, et fertilise le pays habité par les tribus de Dauletkhail et de Gandehpour. Il se dessèche au défilé de Pezou, et son lit ne se remplit plus d'eau que dans la saison des pluies; alors seulement il rejoint la droite de l'Indus, au sud-est du bourg de Paharpour." The *Kurrum* falls into the Indus North of the *Gomal*, while, according to the poet, we should expect it South. It might be urged that poets are not bound by the same rules as geographers, as we see, for instance, in the verse immediately preceding. But if it should be taken as a serious objection, it will be better to give up the *Gomatî* than the *Krumu*, the latter being the larger of the two, and we might then take *Gomatî*, "rich in cattle," as an adjective belonging to *Krumu*.

I have dwelt longer on this point in order to show how much has to be considered before we decide on the Aryan or non-Aryan character of local names in India. Genera Cunningham writes:—

"The name of Kophes is as old as the time of the Vedas, in which the Kubhâ river is mentioned as an affluent of the Indus; and as it is not an Arian word, I infer that the name must have been applied to the Kabul river before the Arian occupation, or, at least, as early as B.C. 2500. In the classical writers we find the Knoes, Kophes, and Khoaspes rivers, to the west of the Indus, and at the present day we have the Kunar, the Kurrum, and the Gomal rivers to the west, and the Kunhar river to the east of the Indus, all of which are derived from the Scythian *Ku* 'water' It is the gutural form of the Assyrian *hu* in Euphrates and Eulæus, and of the Turki *su* and the Tibetan *chu*, all of which mean water or river."

The Ku in Kubhâ admits, as we saw, of a far easier interpretation. The *Go* of Gomal is the Sanskrit *go*, "cow," and the *Ku* of Kuram or Kurrum is the first syllable of *Krumu*, which is derived from "*kram*," to stride.

Although on minor points like these, and particularly on linguistic questions, some of General Cunningham's statements are open to criticism, the book as a whole is a valuable contribution to our knowledge of the ancient geography of India, and we hope that this first volume will soon be followed by others.

MAX MÜLLER

OUR BOOK SHELF

Epilogo della Briologia Italiana. Del Dottore G. de Notaris, Professore di Botanica e Direttore dell' Orto Botanico della R. Universita' di Geneva. (Geneva, 1869; London: Williams and Norgate.)

DR. DE NOTARIS is so well known in this country by his numerous works on mosses and microscopic fungi, as well as by his liberality to correspondents, that it was with great pleasure that we received the noble volume before us, published at the request and expense of the Commonalty of Geneva. It was not to be expected that a country like Italy, where the borders of the Mediterranean are not rich in mosses, should present much novelty, the more Alpine parts yielding very much the same species as the Alpine or more temperate parts of the European districts. It is, however, always interesting to compare the floras of different countries, even where species are so widely spread as the lower Cryptogams, and it is no matter of surprise to find that there are here very few genera which are not amply represented in our own flora. The only genera which have not at present occurred in this country are Lescuræa, Habrodon Anacamptodon, Fabronia, which is essentially a genus of warmer climates, Dubyella, Oreas, Pyramidium, Conomitrium, Oreoweisia, Septodontium, Angstrœmia, Trematodon, Braunia, Coscinodon, Bruchia. Most of these are genera either containing one or very few species. The following European genera, excluding those found in the British Isles, seem not to occur in Italy: Voitia, Sporledera, Pharomitrium, Eustichium, Pyramidula, Psilopilum, Anisodon, Platygyrium, Thedenia, most of which contain only a single species. The only genera of the British Isles which do not occur in Italy, are Daltonia, the single species, *D. splachnoides*, being confined to one or two localities in Ireland, Œdipodium, Discelium, Bartramidula, Anomobryum, Tetrodontium, Glyphomitrium, Hedwigidium, Anodus, which again are genera for the most part of one species only, so that Italian muscology cannot be considered as essentially different from that of other European districts. There are undoubtedly many good species which do not occur in this country, but it is probable that the number of these will be much reduced, one of the most curious, *Buxbaumia indusiata*, having been found by Dr Dickie at Aboyne in Aberdeenshire. It is much to be wished that some Italian botanist would give a similar work on Italian fungi. The truffles and puffballs of Italy have been admirably worked out by Vittadini, and something has been done for the more noble fungi by Viviani and others, but we ought to look to Italian mycologists for the identification of the fungi of Micheli. There is no doubt that any skilled mycologist would be well rewarded by the investigation of the Italian woods, which doubtless contain numerous interesting species. We must, however, look to the Italians themselves for information, as many difficulties would stand in the way of a person not intimately acquainted with the language of the peasantry. We see no reason why as perfect an enumeration of the fungi should not be given, as that of the Italian mosses now before us.

M. J. BERKELEY

LETTERS TO THE EDITOR

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

Thickness of the Crust of the Earth

ARCHDEACON PRATT has given just the answer I expected to my remarks on his defence of Mr. Hopkins. As I said at the time, I scarcely thought it possible that he could have fallen into the mistake of supposing that the disturbing forces to which precision and nutation are due act by fits and starts But note what follows from this. His whole defence of Mr. Hopkins's method

falls to the ground. The very life and soul of that defence was, in almost his own words, that the disturbing forces produced the motion due to their action before friction *had time* to act; or, in other words, that the disturbing forces gave a pull so sharply and quickly that they did their work before friction, which the Archdeacon looks on as rather a sluggard, could rouse itself and counteract them, that they were, in short, able to steal a march on friction each time they gave a pull or a push.

Now it is clear that this explanation has no meaning in it, unless the action of the disturbances is intermittent. Archdeacon Pratt admits that he never supposed that this is the case, therefore he must find some new line of argument, if he wishes to continue his chivalrous defence of his old friend and, I believe, tutor, who can no longer speak for himself. I may add that all who knew Mr. Hopkins personally, and even those who, like myself, only knew of him through common friends, will appreciate and admire Archdeacon Pratt's championship, even if they are unable to agree with him.

In his last letter (NATURE, August 31) Archdeacon Pratt has given a new and independent method, which leads him to the conclusion that the earth is solid from surface to centre, or nearly so; so that if we accept his reasoning we must admit that, whatever may be said of Mr. Hopkins's method, his results at last are right. He mainly rests his argument on the consideration that such a limp thing as an earth with a crust not more than 100 miles thick could not stand the strains with which the disturbing actions of the sun and moon are for ever trying it.

How will it be, though, if we can show cause for believing that the crust of the earth is after all somewhat of a limp thing, and yet does stand these strains? All *a priori* reasoning must give way to fact, if that fact can be established; and though we may be surprised that so thin a crust is able to hold out against the violent treatment it has to undergo, yet, if we can show good reason for believing that the crust is, after all, thin, we must cease to wonder, and try to explain the seeming anomaly.

I shall content myself now with putting forward one of the several grounds on which the thinness of the earth's crust can be, I will not say established, but rendered highly probable; and if my arguments shall prove in the end to have any weight, I have no fear that the seeming contradiction between them and the reasoning of Archdeacon Pratt and Prof. Thomson in the other direction will sooner or later be explained away.

Everyone is familiar with what is known in Geology as Upheaval and Depression, that over and over again during the earth's lifetime portions of the solid crust have been raised, and others lowered relatively to a fixed datum, such as the sea level. Very naturally the idea springs up that the displacement is produced by a thrust acting vertically upwards, or by a removal of some vertical support below. Some cases of small local upheaval may have been brought about in this way, but this is not the machinery by which nature has acted on the large scale.

The fact of upheaval is brought home to us when we find strata originally formed beneath the sea now high and dry far above its level; how the upheaval was brought about we learn by recollecting that these strata were originally horizontal, noting whether they are displaced from that position, and, if so, after what fashion the displacement has taken place. Isolated observations show us strata in some places horizontal, in others inclined at different angles to the horizon; but when we combine into one view a large number of such observations, the result is that we see that the strata have been folded into troughs and arches, that when we find horizontal beds we are on the summit of an arch or the bottom of a trough, where inclined beds appear we are on the slopes. Further, we invariably find that the crumpling up of the strata has been most violent in those parts of the earth's surface which have been raised highest above their original position, that is, on mountain chains. We come, then, to the conclusion that the way in which upheaval has been produced has been by a folding of the strata into troughs and arches. That the crust of the earth, instead of being a rigid unyielding mass, has been from time to time bent into folds, and, so to speak, crumpled up and wrinkled; that it is not unlike, what it has often been compared to, the shrivelled skin of an old dried apple.

Again, the supposition of a thin crust and an internal molten nucleus, gives a very satisfactory explanation of the way in which the crumpling is produced. As the nucleus cools it contracts, and the crust has to accommodate itself to the diminished support within; it cannot shrink, and therefore it gets crumpled, just as in the case of the apple, the inside shrinks more than the skin, and the latter in consequence wrinkles up.

Here, then, is an argument in favour of no very great thickness and a certain amount of limpness in the earth's crust, and it is not the only one of its kind; on the other side, are Archdeacon Pratt's and Sir W. Thomson's weighty reasons in favour of its rigidity. Far be it from me to attempt "tantas componere lites." I only wish to show that there are two sides, and two very good sides, to the question.

What Mr. Hopkins has done seems to me to amount to this: he has shown that with a solid earth the amount of precession would be almost exactly what it is; but he has not shown that this would not equally be the case with an earth having a thin and a *viscous* melted interior; that case he has not attempted to handle, the case he did examine being that of a thin crust and a perfectly fluid interior. If it can be conclusively proved that the thin crust and viscous melted interior are incompatible with known astronomical and mechanical phenomena, we must give them up, but till that has been done we are bound to remember that, whatever has been said against them, there is something in their favour also.

A. H. GREEN

Barnsley, Sept. 8

Temperature of the Sun

I HAVE just seen the interesting note of Mr. Ericsson in the number of NATURE for July 13 (p. 204), and I am very glad that, this question should be thoroughly ventilated.

Mr. Ericsson and others have been startled at the high degree of temperature at which I have arrived, and the appellation of *extravagant* is not spared. I beg leave, however, to observe that this conclusion does not materially differ from that obtained by Mr. Waterston. I am surprised that my opponents, satisfied with rejecting the result as extravagant, do not examine if the method is correct or not. The only objection that could be made is, that, while from the experiments of Soret, the resultant figure is 5,334,840° C., I doubled it, on account of the absorption which the radiation suffers in the solar atmosphere, whose integral effect is a great deal larger than Mr. Ericsson supposes; and it would not be waste of time to discuss the experiments which prove that the absorptive power of the solar atmosphere is very considerable. Mr. Ericsson passes over this too slightly, saying that this absorption would be only 0·01 of the whole, while I have found it considerably greater.

Mr. Ericsson refers to the explanation which I subjoined about this high temperature, that it is to be regarded as a *virtual temperature*, as if these were words *which I would not attempt to explain*. The explanation was, however, given very clearly in my own book, perhaps too shortly, since it seems not to have been understood. The word *virtual* was also employed by Mr. Waterston to indicate the degree of temperature which would be produced in a thermometer by the accumulated radiation of different transparent strata. And indeed this is not an absurd statement and incapable of conveying information, as Mr. Ericsson seems to suppose.

First of all we must admit that a gas exposed to a radiating source does not always attain the same temperature as a solid body. It is obvious, for instance, that the temperature of the free air at the top of a mountain is a great deal lower than the temperature of the thermometer exposed to the sun. This is due to the small absorptive power of the gas. Therefore, at the boundary of the solar atmosphere the temperature of the transparent gas may be a good deal lower than that of a solid thermometer (if by hypothesis it could preserve there its solidity). It is besides not incorrect to say that the different successive strata may add their own radiation, so that by two, three, or more radiating strata we could obtain a higher temperature than by a single one. At least this has been understood, even by M. Respighi, who, however, is of the same opinion as Mr. Ericsson about the exaggeration of my result. The integral effect of all the strata that contribute to this elevation would be the indication of the thermometer, which may be higher than the temperature of a single outside stratum subjected to external radiation.

Mr. Ericsson says that it is of no consequence whether the sun's photosphere belongs to the class of active or sluggish incandescent radiators. I think, however, this point to be very important. Since we cannot experimentally determine the temperature of the sun except by using its radiating power, it is very interesting to take into account this element as very substantial. Very few, indeed, will allow that which Mr. Ericsson takes for granted, that

the radiating power of the solar materials may be compared to that of pure lamp-black, as he assumes at the end of the note.

Mr. Ericsson spends a great part of the note in proving that the law of the diminution of radiation according to the square of the distance is accurate, which certainly I have never questioned. The difference between his own result and mine may perhaps be due to a difference in the use or construction of the instrument; but as, unhappily, I have no information of this construction, I cannot attempt any discussion of his principles. I can only say that his table cannot be used in all seasons indifferently, since I have proved that at the same zenith distance, the absorption of solar heat is very different in summer and in winter, on account of the different quantity of aqueous vapour which is found in the atmosphere. And hence the deductions which he makes about the difference of radiation in aphelion and perihelion may be merely accidentally accurate, and not very conclusive.

On the whole, however, I see that the researches of M. Ericsson approach my results a great deal more nearly than those of M. Zöllner, who fixes the temperature of the lower stratum of the solar atmosphere in contact with the photosphere at 68,400° C. only. And this is a number sixty times less than that of Mr. Ericsson, while mine is only thirty-seven times greater.

The conclusion which spontaneously flows from such extraordinary differences is, that we are yet far from having any exact information on the subject, and I hope that this question will now be better discussed, and that I may be able to find some improvement to be made in my book.

Rome A. SECCHI

Neologisms

I THINK the most suitable word to indicate plane-direction is "position," though the word "pose" would serve, and has, indeed, been used in that sense. The word "position" bears the same relation to the word "direction" that "Stellung" bears to "Richtung," or "set" to "righting." "Position" is often (but incorrectly) used to indicate *place*, but we may reason with Colonel Mannering, *Abusus non tollit usum*—the abuse of anything doth not abrogate the lawful use thereof. This recognised, the words "position of a plane" can bear no other meaning than that referred to by Mr. Wilson. For the purpose of indicating place, the word "location" would be convenient, but that it suggests to the Latinist a "setting to hire." Our American cousins (very wisely, I think) neglect such trifles.

By the way, is not the word "neologism" very ugly and unnecessary? We must have new words, but need we call them neologisms?

As to the invention of new words, I take it that every author who has anything new to say must sometimes want a new word, in which case he has as fair a right to invent and use such a word as to describe new ideas. If this is not the case, I must plead guilty to a grievous series of offences. In fact, I have received during the past year about a ream of letters rebuking a practice which I consider fully "in my right." You should not speak, writes one, of "a limitless expanse," but of an "unlimited expanse;" you must not say "forceful analogy," urges another, but "forcible analogy;" not "star-cloudlet" says a third, but "nebula;" not "square to" but either "perpendicular" or "at right angles to" says a fourth, and so on. So must you write if you wish to be understood, say these critics; or rather they say, "It is indispensable for the adequate conveyance of your meaning that you should thus conform to established usage."

I am not jesting; these words have not only been employed by one of my anonymous critics, but have been seriously suggested for my own use. In some cases modes of expression are vilified: for instance, it seems you must not say of Venus that she is "nearer to the sun than the earth is," for this is inelegant; you must say that she is "nearer to the sun than the earth;" and, in like manner, for the sake of euphony, one should say of Mercury that he is "nearer to the sun than the earth," rather than that he is "nearer to the sun than to the earth." My attention has been directed to each of the expressions here corrected as characterised by a vice of style. So that, since Venus in inferior conjunction is nearer to the earth than to the sun, but nearer to the sun than the earth is, she is (when so placed) at once nearer to the earth than the sun, and nearer to the sun than the earth,—a statement which appears to me less instructive than might be desired. But possibly I am prejudiced.

It is well to keep (where one may) within dictionary precincts, nor need the writer neglect the rounding of his periods; but, in my judgment, he should set before both these things what the above quoted critic calls "the adequate conveyance of his meaning." RICHD. A. PROCTOR

Brighton, September 9

THERE remains but one point to notice in reference to the hybrid (or monster) *prolificness*. Dr. Latham pretty well exhausts its etymological bearings. There remains its phonological bearings to consider. No new word has a chance of being naturalised unless it can be pronounced as well as written; and the greater the difficulty of pronunciation the less is that chance. Now, in order to render Mr. Wallace's word acceptable, it must be pronounced as if it were written, *prollyfickness*, in which phonetic form we almost lose the parent adjective. The reason of this is, that the syllables *ic* and *ness* will not inosculate. To use Mr. Sylvester's phraseology, there is not a perfect anastomosis, and this imperfection is remediable only by change of accent, viz., passing on the accent from *lif* to *ic*; otherwise we must sacrifice anastomosis, and write the word as a compound, *prolific-ness*, *i.e.*, with a hyphen to indicate the necessity of a pause in that place. Surely on all accounts *prolificence* is by far the better word.

Yoxford, September 7 C. M. INGLEBY

The Aurora

I HAVE just read Mr. Wilson's interesting paper entitled "Some Speculations on the Auroras," published in your periodical for September 7. In the *Philosophical Magazine* for July 1870 I made a suggestion as to the origin of auroras similar to that just published by Mr. Wilson.

The periodicity in auroral displays noticed by Mr. Wilson had not attracted my attention. It would doubtless, if it were well established, be confirmatory of the views independently put forward by Mr. Wilson and myself. A. S. DAVIS

Meteor

ON Saturday, September 2, at 8.14 or 8.15 P.M., I saw a fine meteor under very favourable circumstances. I was standing with several friends at the door of Mr. W. F. Moore's house at Croakbourne, in the Isle of Man, and we were looking up at the western sky at the moment when the meteor came. It started between, I think, γ and π Herculis (it was too cloudy to see those stars), descended nearly vertically, passing through Corona Borealis, and vanished a little below ζ Bootis, at about 15° above the horizon. It moved slowly but continuously, taking from two to three seconds in travelling over 45°. It broke into three, which followed one another, connected and followed by a luminous train which was visible for about one second. The first part of the three was brilliant white, and was estimated by Mr. A. W. Moore and myself independently as equal in size to $\frac{1}{3}$th of the moon's surface. It was very brilliant, being mistaken by the Rev. John Howard, who was looking in another direction, for a flash of lightning. The two latter globes were blue.

Rugby, September 6 J. M. WILSON

The Earthquake at Worthing

IN your issue of the 31st ult. is an extract from a letter which appeared in the *Times* a day or two before, giving a very circumstantial and a somewhat sensational account of an earthquake which took place at Worthing, at 3.45 on Monday morning, the 28th of August. Is it not possible that there may be some connection between the said earthquake and the circumstances narrated as under in the *Brighton Gazette* of the Thursday following? If so, might it not be on the whole more prudent of correspondents of the *Times* or other papers, before they rush frantically into print on such subjects, just to put a question or two to some imperturbable old fisherman (if they be shaken out of their wits again at a watering place) instead of appealing to hysterical ladies and excitable old gentlemen for their notes of an event of great scientific interest?

"'What's that? An earthquake! There it is again! Now again! And now again!' These were the exclamations which paterfamilias and materfamilias and lots of juveniles, roused from their slumbers, uttered on Monday at 3.40 A.M., just before the break of day. It was a strange noise; lights flashed from win-

dows, bells were rung violently, windows were thrown up, and cries of 'Thieves' and 'Police' were shouted. But there was no earthquake, there were no thieves, although there were the police, by whom the sounds were distinctly heard. It was some time before all was again quiet, and not even then in many a household until processions in curious garb, armed with sticks, pokers, shovels, and fire-irons, in place of fire-arms, had paraded from kitchen to garret in search of the supposed nocturnal marauders. And now the cause of all this has been discovered. It was the coastguard squadron, a few miles out at sea, having what is termed their night quarter exercise—a turn-out drill in the middle of the night, so as to fit the men for action in an emergency."

E. A. PANKHURST

Church Hill, Brighton, September 11

A Fossiliferous Boulder

DURING a visit I made in July last to a respected friend at Dinnington, Northumberland, I observed a traveller boulder in the corner of his field, and, on closer inspection, found that it contained a number of ammonites, encrinites, and the detached portions of the stems of the stone lily, usually found in the Lias in the vicinity of Whitby. The composition of the boulder, which was about two feet in length, and of proportionate breadth and depth, was basaltic or trap, and had evidently taken up the fossils when in a state of fusion; some of the ammonites being compressed or disturbed. Upon inquiry, it appeared that my friend had sunk for a well, and came at the depth of about twelve feet upon the native freestone rock, upon which this boulder was found. Of course it must have been transported to its place of deposit by ice during the glacial period of our world's history, and then covered over by the subsequent boulder-clay; but from whence was it transported? From Yorkshire or the Hebrides?

I also visited in the immediate vicinity what was formerly the site of an ancient lake of about 1,200 acres, Prestwick Car. This sheet of water was drained a few years ago into the Pont rivulet, and the bed of the old lake is now, through the enterprise and skilful industry of the farmer, covered by luxuriant crops of oats with magnificent heads, approaching six feet in height, and immense thickness of stem. The land, as might be expected, is a deep bog earth; the surface, however, is remarkably light, apparently a leaf soil, and easily disturbed, or blown away by the winds. The remarkable point here was, that after the drainage had been completed, the earth solidified and put under culture, the roots and a portion of the stems of trees broken off near the roots, appeared as if rising from the earth, the prior existence of which was unseen and unknown, indicating the remains of a primæval forest: no branches appeared. The wood is that of the alder. Was not the lake originally formed by the destruction of this ancient forest by the agency of wind?

Barbourne, Worcester, Sept. 9 J. BROUGH POW

A Vital Question

PRAY do not mind if I am alone in my venturesomeness, but in the name of Science, not that which is falsely so called, but that which depends upon evidence, let me protest against the doctrine contained in the concluding portion of Sir W. Thomson's address. Scholastic theology has for me nothing worse than the declaration, made on the strength of a mere dogma, that our dear mother earth is no mother at all, but absolutely incapable of filling any function in the production of her own children. The dogma that life can only proceed from life, appears, when analysed, like too many another dogma, but a meaningless jingle of words.

Here are three counter-propositions, which I advance in all confidence of their soundness:—

1. We know nothing whatever of the nature of life to justify us in asserting its absolute difference in kind from many other phenomena, as of magnetism, chemistry, or Nature in general.

2 If, as astronomers hold, all the bodies composing the solar system are derived from the sun, they must contain identical elements. That their elements are actually identical is, moreover, indicated by the spectroscope. So that if those elements be incapable of producing life on this planet, they must be incapable of producing it elsewhere. However much reason there may be to suppose they have not produced life in any particular instance *as yet*, as, *e.g.*, in our satellite, that is no reason against their doing so in the future. If Sir William's object had been *to gain time* for existing evolutions, I could have forgiven him, but there was no hint of this.

3. To speak of life as necessary to the production of life, is to ignore all that Science has ascertained respecting the transference and convertibility of force, and to fall back upon the anthropomorphism of the theologians, only with the difference, in this case, that it is not Jupiter, but "the stone that fell down from Jupiter," whom we are to hail as our father and mother. Moreover, to speak of life as necessary to the production of life, is to assume that we already know the limits of Nature's productive power; and to assert that life is not a natural product at all, is to restrict our definition of Nature by some arbitrary limit which excludes the most important functions of Nature.

Doubtless it would be a very pretty idea to regard the planets as so many orchids in the flower-garden of the Universe, and the meteorites as their fertilising bees; but Sir W. Thomson entertains no such pleasing sentiment respecting the earth. He degrades this unhappy planet far below the meteorite.

Once upon a time we were astray with a companion in a far Western wilderness, we were reduced to eating anything that we could find. On the question arising whether rattlesnakes were fit to eat, I propounded the dictum that whatever could itself live ought to be able to support life in another, and our experience, so far as it went, confirmed the saying I venture to vary it for Sir W. Thomson's benefit, and to suggest that whatever can support life, as this earth does, can in all probability produce it.

Loving, as I do, both the world and the things which are in the world, I hope you will not refuse me a corner for this sorrowing dissent from a doctrine so depreciatory of the world, and whose enunciation cannot fail to give occasion to the many enemies of Science to blaspheme its sacred name on account of the eccentricities of its professors.

EDWARD MAITLAND

Oxford and Cambridge Club

Draining a Cause of Excessive Droughts

WILL you kindly allow me through the medium of NATURE to ask whether any of my fellow readers can give me any *actually observed facts*, to show that draining is justly considered an item in the sum of causes which have given rise to the lengthened periods of drought that we have experienced in these islands for the last few years. As a matter of reasoning I believe it is generally admitted that such is the case, for ample evidence has been produced by actual experiment to show that draining raises the temperature of the land and the air above it; and if so, it would lessen the chance of the vapour suspended in the atmosphere being condensed. Such observed facts are on record as regards the cutting of forests, *e.g.*, NATURE, vol. iv. p. 51, "Buchan's Meteorology," p. 88, and if my memory does not fail me, some information was given on both these points in a previous volume of NATURE, but I am at present unable to lay my hands upon it, though I have glanced over the pages as well as the index.

If any one will kindly furnish me with the information, which may also be of interest to others, or refer me to a work not difficult of access, I shall be extremely obliged.

THOMAS FAWCETT

Rainbow

ON Friday, the 8th July, about four P.M., as I was driving across the Bog of Allen, about eight miles from Edenderry, I observed the most brilliant rainbow I have ever beheld either in Europe or India. It appeared in the North, and was low down on the flat horizon, being an arc of 60° with the horizon as its chord. The ends of the bow were nearly due E. and W. The spectrum was intensely vivid. A second bow, imperfect towards the centre, shortly afterwards appeared above it; in perhaps five minutes, the E. end of this upper bow faded, and immediately I perceived for a corresponding length of the true rainbow, bordering the violet, a well defined rim of sea green, this bounded by a band of almost mauve-coloured violet, which shaded off into the indigo sky.

The under-side of the opposite end of the bow (above which the portion of the upper bow was still visible) presented no such appearance.

Next day I learnt that, about the same hour, a thunderstorm

burst over Edenderry, and the telegraph clerk, on going to work his instrument, was instantly struck senseless to the ground.

Now, are the two bands beyond (*i.e.* below) the violet often seen? for I never before observed them; or are they due to an unusual amount of electrical tension in the atmosphere?

And is the second incident an unusual occurrence in telegraph offices? F. G. S. P.

Earthquake in Jamaica

ON the night of the 20th inst., at twenty minutes past nine, a sharp shock of earthquake was felt throughout the island, accompanied by a loud rumbling noise. The undulations were from the north.

ROBT. THOMSON

Cinchona Plantation, Jamaica, August 23

An Inquiry

CAN any of the readers of NATURE inform me whether Dr. Anderson, who in the capacity of naturalist, accompanied Captain Sladen's expedition from Bhamo to Momein in 1868, published any papers upon the scientific results of the journey?

If I am not mistaken, Dr. Anderson was a candidate for the Chair of Natural History in Edinburgh last year, and died before the election.

F. R S.

PROF. HAYDEN'S EXPEDITION

WE learn from *Harper's Weekly* that advices from Prof. Hayden's exploring expedition in the Yellow Stone Lake region have been received up to the 8th of August last, and contain a satisfactory exhibit of progress. After establishing the depôt of supplies already referred to on the Yellow Stone River, about one hundred and forty miles below the lake, the party ascended the river, and reached the lake on the 26th of July, where they made a new camp. They then began at once to survey the lake with the most approved apparatus, by the aid of a boat taken along for the purpose, and expected to be able to ascertain the exact contour, as well as the principal depths. They had already found several places in the lake where the depth reached three hundred feet, especially along the line of a certain channel-way, and they confidently expected to find soundings of at least five hundred feet.

They explored one of the islands in the lake, which they called Stevenson's Island, and found it to contain about fifteen hundred acres, densely wooded, and with thick and almost impenetrable underbrush, consisting largely of gooseberry and currant bushes, loaded down with ripe fruit. On the threshold only of the wonderful natural phenomena in the way of geysers, boiling springs, &c., described by Lieut. Doane and Governor Langford, they were satisfied that the description fell far short of the reality, which they, indeed, despaired of being able to pourtray, even with the aid of photographic views and sketches.

One of these geysers once in thirty-two hours threw up a column of water about eight feet in diameter to a height of over 200 feet. Hundreds were met with having columns of from ten to fifty feet high, some playing all the time, and others only at intervals The hottest springs were found to vary in temperature from 188° to 198°, the boiling point at that altitude amounting to about 195°. Most of the springs were ascertained to be divisible into two principal classes, one class containing silica, sulphur, and iron, and the other silica and iron only.

The elevation of the lake was determined to be about 8,500 feet; the altitude of the surrounding peaks being, of course, very much greater. An abundance of trout was found in the waters, of excellent flavour, although much infected with intestinal worms. Game was scarce immediately around the lake; but at a short distance it was said to be very abundant. In addition to the topographical and geological collections, others were being made in all branches of natural history, for a full account of which, as well as a description of the phenomena in general, we shall look with interest to the forthcoming report of the expedition.

MR. GEORGE HODGE

WE greatly regret to record the death, at Seaham Harbour, on the 7th of September, after a short illness, at the age of thirty-eight, of this accomplished naturalist. Although from his retiring and unassuming disposition, little known beyond the naturalist circles of the north, George Hodge realised, as few do realise, the objects of a local naturalist. Living on a portion of the north-east coast, the marine fauna of which was practically uninvestigated when he first settled there, he made its patient and honest study the business of the scanty leisure left him by heavy business responsibilities. How far he succeeded is best evidenced by the Natural History Transactions of Northumberland and Durham, his favourite medium of publication for his careful observations and exquisite drawings of the lower animal forms. During a temporary residence in Newcastle, he was honorary secretary to the Natural History Society, and was to the last a valued member of its committee.

Mr. Hodge was a most enthusiastic dredger; if he could get a boat to sea on a fine day (this being even more of a desideratum with him than with most men, as he was rather easily upset), he was perfectly happy. The last two dredging expeditions conducted by the Tyneside Naturalists' Field Club, with grants from the British Association, were undertaken chiefly by him in conjunction with Mr. G. S. Brady. The Echinodermata were his favourite subjects of study, but he was also specially interested in the Zoophytes, Pycnogons, Crustacea, and marine Acari, among all of which he had done good work. To his influence chiefly may be ascribed the establishment of the very useful and flourishing Natural History Club of Seaham Harbour, in whose proceedings he always took great interest.

ELEMENTARY PRACTICAL GEOMETRY

AS "A Father" has asked me by name in your columns what book I can recommend as laying a foundation for the geometry of the future, I suppose I ought to answer him, though I cannot do so by a simple reference to a book. I think the main object of early geometrical teaching should be to lay a foundation of familiar facts on which the science will afterwards be built up. This is unquestionably the true scientific method in teaching all subjects; and as yet it has never, or very rarely, been applied in Geometry. For example, no intelligent teacher of botany will begin by classifying flowers, or teaching theories about their structure; he begins by giving his class flowers to dissect, and then they will know what he is talking about; and teachers of chemistry who follow any other plan find themselves inevitably compelled to cram their pupils. The question is, *how* is this method to be applied in Geometry? I know from various sources that there is a pretty wide-spread conviction that it ought to be so applied, but there is a difficulty that meets teachers at once: there does not seem to be enough of practical geometry that is sufficiently easy for children; and practical geometry, as presented in text books, is dull and uninteresting, as well as rather hard. Still my conviction remains that to lay a foundation of knowledge of facts is as necessary in Geometry as in other sciences, though the range of facts easily observed is somewhat less, and the science becomes much sooner a deductive

one. And I think it is admitted that because this observational or practical geometry is wanting in our elementary mathematical teaching, geometry is generally found so difficult, so inexplicably difficult, by boys.

It does not suffice to give a child a box of geometrical solids, and let him handle them and learn their names, though this is not useless. Nor does it suffice to give him a ruler and a pair of compasses to play with; and, in fact, the more we reflect on what is required to give an interest to the observations out of which familiarity with geometrical facts is to spring, the more inevitably, it seems to me, are we led to the conclusion that practical geometry is to be taught not *per se*, but by practical work, by interesting and varied applications of geometrical methods to measure and copy actually existing things.

And this at once suggests that the elementary teaching of practical geometry should consist in the manipulation of measuring instruments, and the calculations based on these measurements, which lie at the foundation of sound scientific work. I believe that all such measurements and calculations and practical constructions as are within the range of a boy, might be profitably laid before him as his work in elementary geometry: and I believe that this kind of training would moreover be of the very highest value in preparing him for good experimental work, and for a sound appreciation of scientific methods and results.

It will be advisable, however, to go into some degree of detail in order to explain my meaning to such as are not familiar with these parts of education; and in doing so, I must confess that I have not tested these details throughout by actual experience. For we have at Rugby to deal with older boys than those whom I am now contemplating, and though we do something of the kind with our younger boys, yet it is not what I should choose if I had the control of boys' education from an earlier age. Any one who wishes to see our actual course of practical geometry can do so by ordering Kitchener's "Geometrical Note-book" from the publisher of NATURE. But it must be understood to be a stopgap, and not a complete work. (I trust the author will forgive me for saying so.)

Let a boy be furnished with a ruler, a triangle (in plain wood), a pair of compasses, and a protractor. Let him have a hard pencil, and be taught how to sharpen it. First let him draw on card a decimetre scale, divided into centimetres, and in part into millimetres. This, of course, he must copy from some trustworthy scale. Insist on this, and on every part of his work being done with great care and perfect neatness, and therefore not in ink.

These are his tools. He must proceed to measure some figures provided him for this purpose; a few triangles, quadrilaterals, &c., in wood, or figures drawn on paper, are sufficient for this purpose. Every one of his measurements is neatly written in a suitable note-book, and the figure to which they apply is drawn (freehand) therein.

The next thing to proceed to is the measurement of angles, and the expression of the result in degrees and minutes, with exercises suggested by Euclid, i. 32, and its corollaries, properties of the circle, &c., which are to be practically verified, the observed results being written down, and compared with the theoretical results.

Then the lad may go on to the practical measurement of areas, beginning of course with a rectangle, which he divides into square centimetres and millimetres; he goes through the practical proof that the area of the triangle is half that of the rectangle of equal altitude on the same base; he proves Euclid, i. 47, and iii. 35; he finds the areas of various polygons of which drawings or models are given him.

Mensuration of solids is next approached, and here probably a few rules will have to be given, by which volumes are calculated from linear measurements. But in all cases the measurements must be made by the boy himself with his compasses and scale. Any one who pleases can show his pupils how to prove the relation between the volumes of pyramids and prisms by weighing models of suitable dimensions. The same method may easily be applied to determine approximately the area of a circle; and in this, as in some other measurements, it will be well to require an estimate of the degree of approximation attained, and a mean to be taken of several measurements.

If more applications are wanting, the use of co-ordinates to express position may be explained, and some examples may be given of their application in simple problems, such as to make a plan of a room or of a garden, the scale being specified; and to copy a drawing, such as the sun with a group of spots. More advanced work to any amount will be offered by projections. The boy would be required to draw the projections of the various regular solids given to him, and perform the usual exercises of geometrical drawing. The construction by ruler and compasses of exact copies of triangles and other figures may be introduced almost anywhere, and a clear statement given of the different data from which a triangle can be constructed.

I wonder what "A Father" and mathematical teachers say to these suggestions. It will be obvious that they do not aim at making a boy a rapid analyst, or an expert problem solver; but I hope it is equally obvious that they are really calculated to make a careful and exact worker, one who shall attach precise meaning to his words, and shall be capable of using his head and hands in combination with one another in practical problems. The method is, moreover, applicable to a class, as well as to an individual pupil, and involves a very trifling expenditure on materials.

When some such course of practical geometry has been gone through, a boy may begin any scientific or deductive geometry; he had better read whatever book is read in the school to which he is going. A boy so prepared will find Euclid easy enough, but rather unaccountably indirect and clumsy; but he may be fortunate enough to be going to a school which has adopted some better arranged text book. In a year or two there will be better modern text books than now exist. Whatever book he reads, he ought to work many examples, and do original work. It is not a bad plan to give him the enunciations alone, and let him discover the proofs as far as he can. Perhaps the best text book now existing is the "Eléments de Géometrie," par Ch. Briot.

My remarks have run to considerable length, much greater than I intended, and I can apologise for it only on the ground that many teachers are thinking of the question handled in it, and that it is only by imparting our notions and our experience to one another that we shall improve our methods. I sincerely hope that "A Father's" letter to you may elicit answers from teachers more experienced and successful than I am.

J. M. WILSON

ON FRESH DISCOVERIES OF PLATYCNEMIC MEN IN DENBIGHSHIRE

IN the course of 1869 I had the good fortune to discover and explore a sepulchral cave at Perthi Chwareu, a farm about fourteen miles north of Corwen, and high up in the region of hills. It contained fifteen or sixteen skeletons, some of which were buried in a sitting posture, of ages varying from infancy upwards, and associated with the broken bones of animals that had been eaten, which belonged to the dog, fox, badger, horned sheep, Celtic shorthorn (*Bos longifrons*), roe, stag, horse, wild boar, and domestic hog. The solitary work of art left behind by man consisted of a flint flake, but there were also fragments of *Mya truncata*, and of mussel and cockle-shells. The cave had been evidently used as a place of habitation

by some early race of men, and subsequently as a cemetery, and since the corpses had been deposited on the old inhabited surface, the human bones were more or less intermingled with those of the animals. The entrance had been blocked up with a barrier of large stones, and the interior was filled nearly to the roof with the fine red silt introduced through the crevices in the roof by the rain. The human remains, which were described by Prof. Busk in the essay on the discoveries published in the Journal of the Ethnological Society, January 1871, presented points of very high interest; for while the skulls were rather above than below the present average cranial capacity, some of the leg-bones were remarkable for the peculiar antero-posterior flattening or platycnemism of the shin-bones. And this flattening was caused by the prolongation of the bone in front of the inter-osseous ridge, and not in any great degree by its posterior extension, which is the distinctive feature of the tibiæ found in the caves of Cro Magnon and of Gibraltar. The fact that these platycnemic leg-bones were associated with others of the ordinary forms, and for the most part belonging to the young, and probably to females, while the skulls were of the same type, proves that the character is not one of race, as M. Broca believed, but rather one peculiar to the individual and perhaps to the sex.

Subsequently, I was able to bring this interesting sepulchral cave into relation with remains of man from other parts of Denbighshire, through the courtesy of Mrs. Williams Wynn, in whose possession were a skull and several long bones obtained some years ago in a cave at Cefn, and of the same type as those from Perthi Chwareu They were found along with the remains of sheep or goat, pig, fox, badger, and stag, and four flint flakes.

A chambered tomb at Cefn, explored in 1869 by Mrs. Williams Wynn, under the care of the Rev. D. R. Thomas and myself, and consisting of a chamber 5ft. wide and 9ft. long, which gradually contracted until it joined a passage 6ft. long and 2ft. wide, contained considerably more than twelve human skeletons buried in the sitting posture, of various ages, and presenting in some cases platycnemic tibiæ. The skulls were of the same type as those from Perthi Chwareu, and some were possessed of peculiar upturned nasal bones that pointed unmistakeably in the direction of a *nez retroussé*. A few small broken flint pebbles were the only foreign matters in the tomb, which was built of large rough slabs of limestone placed on edge, and covered with capstones, and finally buried under a carnedd of loose fragments of limestone. A second chambered tomb with a passage was discovered by the Rev. D. R. Thomas in this carnedd in 1871, which was full of human remains of the same kind as those which I have mentioned, and in addition a few remains of dog, pig, sheep, and roe-deer were found. A broken flint and a round stone were also met with.

The remarkable correspondence of the human remains in the carnedd and the Cefn Cave with those of Perthi Chwareu, proves that the race of men who buried their dead in the tombs is the same as that which used the caves for its last resting-places. The stone chambers, with their low entrance and narrow passage, are indeed caves artificially made, and it is very possible that the idea of making "Ganggraben," or gallery graves, is derived from the ancient custom of living in and burying in caves.

It becomes an interesting question to ascertain the relative age of these cave dwellers and carnedd builders, who have so completely passed out of remembrance that their very name has perished. The evidence offered by the flint flakes may be at once dismissed as being valueless, because they were buried with the dead at least as late as the Roman occupation of Britain, and they merely indicate an antiquity not less than that of the conversion of the Romano-Celts to Christianity, a date which is very hotly contested at the present time. Nor does an appeal to the remains of the animals help us very much. The domestic animals are nearly the same as those still kept in the district, and were introduced into Europe during the Neolithic age. The dog, however, so far as I know, was not usually eaten in Britain in Roman times, although it was an article of food in the Neolithic age in Switzerland and in Yorkshire. The sitting posture also of the corpses points in the Neolithic direction, as well as the correspondence of the skulls with those termed "river bed" by Prof. Huxley, and others which are undoubtedly of the newer stone age. On this evidence, therefore, the Neolithic date of these ancient dwellers in Denbighshire might be inferred with a high degree of probability.

All doubt, however, on the point has been removed by my discovery of a second cave some 300 yards removed from the first, during the exploration carried on by Mr. Lloyd, of Rhagatt, at the end of last August. Like the first it ran nearly horizontally into the rock, and was blocked up with earth and large masses of stone, and it contained the broken bones of the same animals associated with skeletons of the same type. The corpses had been buried in the sitting posture. During the first day's digging we obtained a beautiful polished axe made of greenstone, and with the edge uninjured by use, which had evidently been interred for some motive or other along with the dead, as well as a few splinters of flint, and one well-defined scraper of the same sort as those which the Eskimos use inserted into a handle of bone or antler. We added also the bear, *U. Arctos*, to the list of animals. And subsequently we met with a remarkably fine flint flake rather over three inches in length, which was in juxtaposition to a small heap of human bones belonging to one skeleton, and rested on the ancient floor of the cave that was indicated by a mortar-like mass of decayed stalagmite. There were also many fragments of a rude black hand-made pottery, composed of clay, worked up with small fragments of stone to prevent fracture while it was being subjected to the fire. Some were nearly an inch in thickness; while others ranged from a quarter to half an inch. It is of the same kind as that which is commonly met with in caves, occurring alike in Kühloch and Gailenreuth, and in Kent's Hole, being very frequently discovered in association with Neolithic remains. After clearing out the horizontal passage for a distance of 10ft. from the entrance, we found that it expanded into a chamber, of the dimensions of which we are unable to form an idea, as it was nearly full up to the roof with *débris*. The floor underneath the decomposed stalagmite consists of a tenacious gray clay, which has never yet yielded any remains either in Yorkshire, Wales, or Somerset, and is probably the result of the melting of the glaciers, the traces of which are abundant in the neighbourhood.

A third cave, running into the rock parallel with the last at a distance of 12ft., contained similar remains of man and the animals, as well as a fourth, which stands about half-way between Perthi Chwareu and those of Rhos-digre.

The interest of this discovery consists in the fact that the group of caves which has been used by a race of herdsmen in long-forgotten times as habitations and burial places, and the tombs at Cefn, must be referred to the Neolithic age. And we can now be certain that those people who have manifested the peculiar flattening forwards of the shin in Denbighshire belong to that age. It is a point also well worthy of note that the cranial capacity of these Neolithic men was not inferior to that of the average civilised man, although the ridges and processes for muscles indicated a greater physical power.

The clue to this remarkable series of caves was afforded by a small box of bones forwarded by Mr. Darwin, and obtained from the *débris* of a refuse heap in a neighbouring ridge, on which the Neolithic men happened to hold their feasts. We have by no means yet exhausted the evidence of a social state now unknown in Europe, which is presented by the caves and tumuli of Denbighshire.

W. BOYD DAWKINS

METEOROLOGY IN AMERICA*

THE attempt to presage great weather phenomena is nothing new. From time immemorial civilised society has sought after a plan for averting the violence of the storm and tempest as anxiously as it has sought to resist the deadly approach of the pestilence and the plague.

The Great Plague of London, historians tell us, carried off in a year about 90,000 persons. This was, however, in the rude and undeveloped condition of medical science, when the metropolis of England had but few hospitals,

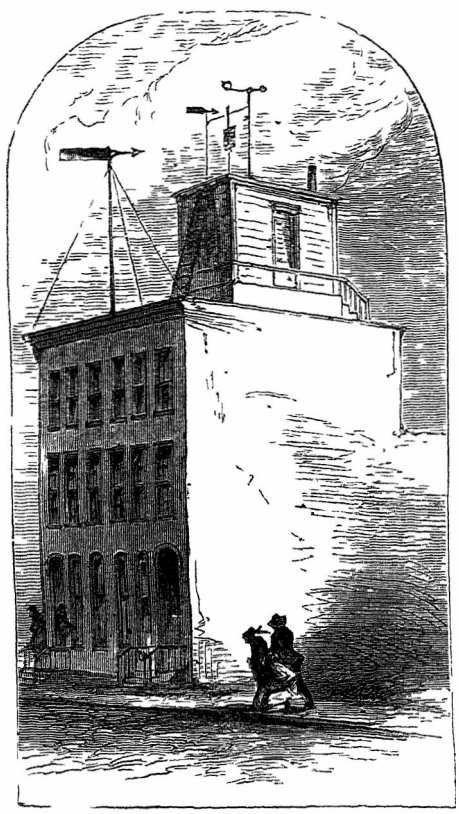

FIG 1.—THE SIGNAL OFFICE AT WASHINGTON

and every victim was left in his own house to spread and speed the march of the contagious foe. Appalling as such mortality seems for the year 1665, amidst the wretched and squalid dens of the London poor, it has been overshadowed in modern times by a greater calamity. On the 5th of October, 1864, the storm which swept over Calcutta destroyed, *in a single day*, over 45,000 lives! Yet this is but one of a large number of similar occurrences rivalling in magnitude the great Indian disaster.

To give forewarning of approaching tempests on the coasts of the Adriatic, the Italian and old Roman castles, as described by an antique writer, had on their bastions pointed rods, to which, as they passed, the guards on duty presented the iron points of their halberts, and whenever they perceived an electric spark to follow, they rang an alarm-bell to warn the farmer and the fisherman of an approaching storm. It is interesting to note that this ancient Italian custom was widely spread over the earth in former ages.

A new element of science has been introduced—the electric telegraph—an invention whose mission of usefulness is destined to unlimited enlargement.

In November 1854, while the Anglo-French fleet was operating in the Black Sea against the stubborn walls of Sebastopol, the tidings flashed across the wires that a mighty tempest had arisen on the western coast of France, and, by the warnings of the barometer, was on its way eastward. The telegram was sent by the French Minister of War, Marshal Vaillant, from Paris, and reached the allied fleet in good time to enable them to put to sea before the cyclone could travel the five hundred leagues of its course, and disperse or destroy the most splendid navies that ever rode those waters. The storm came with a fatal punctuality to the predicted hour. The Crimea, shaken, ravaged, scourged by its fury, presented everywhere a scene of havoc and ruin in the allied camp more fearful than any the fire of all the Russian forts combined could have inflicted. It is perhaps not too much to say that, but for that telegram and its timely storm warning, the congregated navies, far from home and shattered to pieces, could not have sustained the besieging armies, and the event of the great Eastern war might have been different from what it finally was.

So happily, in this instance, did theory (too often despised) blend with fact, that the French War Minister said, "It appears that, by the aid of the electric telegraph and barometric observations, we may be apprised several hours or several days of great atmospheric disturbances, happening at the distance of 1,000 or 1,500 leagues."

So far as we have been able to learn, the first idea of making use of the telegraph for conveying information in regard to the weather, with a view of anticipating changes at any point, occurred to Prof. Henry, the eminent secretary of the Smithsonian Institution, in the year 1847, as in the report of the Institution for that year, page 190 (presented to Congress on the 6th of January, 1848), we find the following paragraph :—

"The present time appears to be peculiarly auspicious for commencing an enterprise of the proposed kind. The citizens of the United States are now scattered over every part of the southern and western portion of North America, and the extended lines of telegraph will furnish a ready means of warning the more northern and eastern observers to be on the look-out for the first appearance of an advancing storm."

Additional references to this subject were made in the reports of 1846 and 1849, in the latter of which we are informed that "successful applications have been made to the presidents of a number of telegraph lines, to allow, at a certain period of the day, the use of their wires for the transmission of meteorological intelligence." Although subsequent reports referred to the intention of the Institution to organise a telegraphic department for its meteorological observations, it was not until 1856, as far as we can ascertain, that observations were actually collected and posted. In the report for 1857 we find that "the Institution is indebted to the national telegraph lines for a series of observations from New Orleans to New York, and as far westward as Cincinnati, which were published in the *Evening Star*."

In the report of 1858 it is announced that "an object of much interest at the Smithsonian building is the daily exhibition, on a large map, of the condition of the weather over a considerable portion of the United States. The reports are received about ten o'clock in the morning, and the changes on the maps are made by temporarily attaching to the several stations pieces of card of different colours, to denote different conditions of the weather as to clearness, cloudiness, rain, or snow. This map is not only of interest to visitors in exhibiting the kind of weather which their friends at a distance are experiencing, but is also of importance in determining at a glance the probable changes which may soon be expected."

*We are very glad to avail ourselves of the courtesy of the Editor of *Harper's New Monthly Magazine*, who has allowed us to reprint, in a modified form, an important article on this subject by Professor F. B. Maury, in which a complete picture of what is being done in America is given It will be seen that in many points our own Meteorological system is inferior to that now in operation in the States. We should add that the woodcuts have also been placed at our disposal by the Editor of the Magazine referred to.

The report for 1859 contains a list of thirty-nine stations from which daily weather despatches are received, and the report for 1860 refers to forty-five stations In the report for 1861 Prof Henry announces that the system has been temporarily discontinued, in consequence of the monopoly of the wires by the military department, and in 1862 it seems to have been again resumed.

It is very evident that to America belongs the credit of first initiating and carrying into successful operation the systematic use of the telegraph for the above-mentioned object

In the year 1857 Lieutenant M F Maury, then Superintendent of the National Observatory at Washington, appealed to the public and Congress, through the press, urging the establishment of a storm and weather bureau, and at the same time made an extensive tour through the

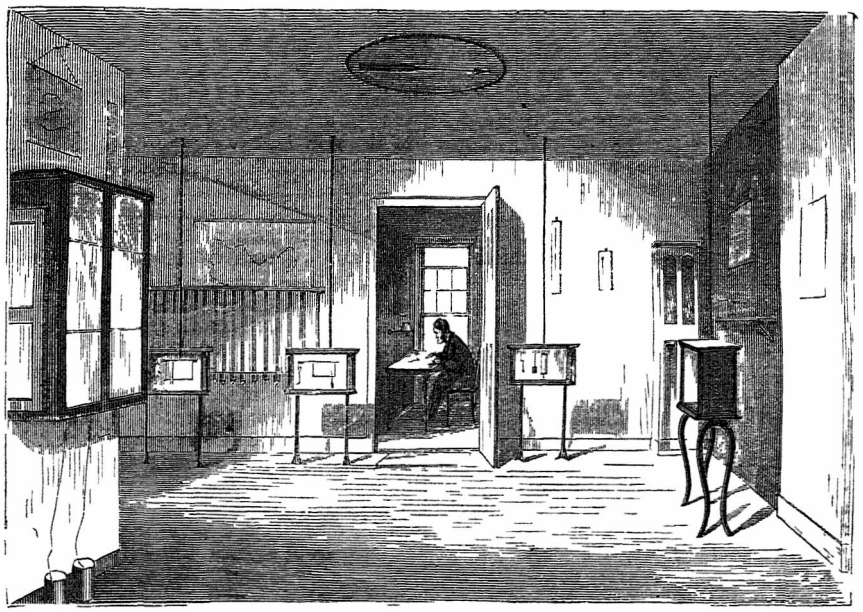

FIG 2 —INTERIOR OF INSTRUMENT ROOM IN OFFICE OF CHIEF SIGNAL OFFICER

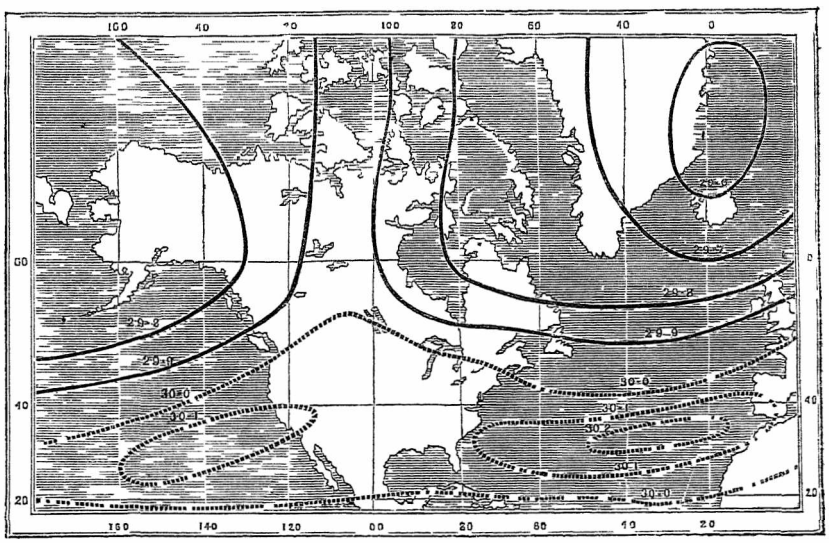

FIG 3 —MEAN ANNUAL ISOBAROMETRIC LINES FOR THE UNITED STATES

north west, addressing the people with a view of rousing public attention to the vast importance of this meteorological system

In the Journal of the American Geographical and Statistical Society for 1860, we read that "As long ago as 1851 we find the Superintendent of the National Observatory at Washington urging the extension to the land—for the benefit of farmers, the shipping in our ports, and the industrial pursuits of the country generally—of that system of meteorological co-operation and research which had been so signally beneficial to commerce and navigation at sea The Brussels Conference endorsed this recommendation Much stress, in these appeals to Congress and the people, has been laid upon the value of the magnetic telegraph as a meteorological implement, for it was held that by a properly managed system of daily weather reports by telegraph warnings of many, if not most, of the destructive storms which visit our shores or

sweep over the land, might be given sufficiently in advance to prevent shipwreck, with many other losses, disasters, and inconveniences to both man and beast" (page 6). The same journal states that the Meteorological Department of the London Board of Trade, under Admiral Fitzroy, was established to co-operate with the suggestion of Lieutenant Maury, which statement is confirmed by the report of the English Board for 1866 (page 17), and also by Admiral Fitzroy himself, in his Weather Book, where he tells (page 49), "from personal knowledge, how cold Maury's views and suggestions were received in this country (England) prior to 1853." The great meteorologist, Alexander Buchan, Secretary of the Scottish Meteorological Society, in his recent work, strikingly states the indebtedness of Europe to the United States for this system: "The establishment of meteorological societies during the last twenty years must be commemorated as contributing in a high degree to the advancement of the science. In this respect the United States stand pre-eminent."

Less than three years after the occurrence of the famous "Black Sea storm," just mentioned, there appeared for the first time, and in an American paper, a formal proposition for the establishment of a general system of daily weather reports by telegraph, and the utilisation of that great invention for the collection of meteorologic changes at a central office, and the transmission thence of storm warnings to the sea-ports of the American lakes and our Atlantic sea-board.

"Since great storms," says Mr. Thomas B. Butler in his work on the "Atmospheric System and Elements of Prognostication," "have been found to observe pretty well-defined laws, both as respects the motions of the wind and the direction of their progress, we may often recognise such a storm in its progress, and anticipate changes which may succeed during the next few hours. When it is possible to obtain telegraphic reports of the weather from several places in the valley of the Mississippi and its tributaries, we may often predict the approach of a great storm twenty-four hours before its violence is felt at New York."

On the coasts of the kingdom of Italy mariners are forewarned that a storm threatens them by a red flag hoisted on all the towers and light-houses of the principal localities, ranging from Genoa to Palermo, and thence up along the Adriatic. On the most dangerous points of the coast of England, where the fishing-boats and small craft that perform the service of the coast are exposed to formidable gales even during the most promising season, barometers put up by the Meteorological Bureau are at hand to warn the seamen of bad weather. A striking illustration of the importance of storm weather signals was recently furnished (March 8), when a tornado swept over St. Louis, destroying several lives and 1,000,000 dols. worth of property.

In former publications the writer has demonstrated at length the fire-sprinkled paths and tracks of these storms, some of which are generated in the torrid zone, and sweep over the Gulf of Mexico, and thence up the valley of the Mississippi; or, shooting off from the bosom of the Gulf Stream, strike upon the Atlantic coast, and thence commence their march upon the sea-board and central States of the Union. In these published papers the view taken of these tropic-born cyclones is, with some modifications, that announced in 1831, and then substantially demonstrated by Mr. William C. Redfield, of New York, viz. that they rotate round a calm centre of low barometer, in a direction contrary to the hands of a watch in the northern hemisphere, and with the hands of a watch in the southern hemisphere.

The writer was aware, when this view was first publicly sustained by himself, that it was not accepted by all meteorologists.

The observations, of the most reliable and extended character, made within the last few years, go far to show that the storms which descend on low latitudes of the earth from high polar regions are, as the storms of the tropical regions, likewise of a rotary or cyclonical character.

One of the most beautiful illustrations of the law which governs these atmospheric disturbances may be found in the gale which is so celebrated as that in which, on the 25th of October, 1859, the noble steamship *Royal Charter* went down, and several hundred lives were lost, in sight of the island of Anglesea, on the coast of Wales. "The *Royal Charter* gale, so remarkable in its features, and so complete in its illustrations," as Admiral Fitzroy has well remarked, "we may say (from the fact of its having been noted at so many parts of the English coast, and because the storm passed over the middle of the country), is one of the very best to examine which has occurred for some length of time."

The peculiarity of this gale which swept over the deck of the *Charter* was its *intense coldness*, being a *polar* current.

The phenomena of the *Royal Charter* gale, as detailed in Fitzroy's Weather Book and the publications of the day, are important because they furnish the reader with the type to which most American storms, and, indeed, all storms, more or less strictly conform, as geographical or orographical circumstances permit or prevent.

Storms similar in their conditions to that of the *Royal Charter* not unfrequently occur in the United States, especially in the winter, when the conflict of the two currents, the polar and the equatorial, in high latitudes, is marked by sudden transitions in January from mild, moist, and balmy weather to a sudden and fearful cold, below zero. The great snow-storm which visited Chicago on Friday, the 13th of January last, was from the great polar current, and, as is the wont of westerly storms (from the orographic peculiarity of the country), made its way to the Atlantic along the lakes and through the valley of the St. Lawrence.

"With daily telegrams from the Azores and Iceland," Buchan says, "two and often three days' intimation of almost every storm that visits Great Britain could be had." The Iceland telegram would give tidings from the polar air current, and that from the Azores would advertise the movement of the tropical current.

It is highly important that the United States should have telegrams from the Pacific, and from the valley of the Saskatchawan, or some point in British America on the eastern slope of the Rocky Mountains. The importance of reports from the south-west was also fearfully demonstrated in March, during the already mentioned interruption of the Signal Service.

It is due to the cyclone theory, or "law of storms," here and heretofore advanced by the writer, to say that many of the storms which seem to be deviations from the cyclonic law are modified by *interfering cyclones*. This view was formally adopted by the committee of the Meteorological Department of the London Board of Trade. Mr. Stevenson, of Berwickshire, England, as quoted by Fitzroy in the Board of Trade Report for 1862 (p. 33), has some striking observations, founded on his own invaluable labours: "The storms which pass over the British Isles are found generally to act in strict accordance with the cyclonic theory. In many cases, however, this accordance is not so obvious, and the phenomena become highly complicated. This is a result which often happens when two or more cyclones interfere—an event of *very frequent occurrence*. When interferences of this description take place, we have squalls, calms (often accompanied by heavy rains), thunder-storms, great variations in the direction and force of the wind, and much irregularity in the barometric oscillations. These complex results are, however, completely explicable by the cyclonic theory, as I have tested in several instances. A very beautiful and striking example of a compound cyclonic disturbance of the atmosphere at this place was investigated by me in September 1840, and found to be

due to the interference of three storms." Mr. Stevenson gives a number of instances of interfering cyclones which confirm this view. The points of *interference*, where two cyclones strike and revolve against each other, are best marked by a peculiarly and *treacherously* fine rain.

It may not inappropriately be added here that the cyclone theory, so strikingly illustrated by the hurricanes of the West Indies, has been demonstrated by Dove to apply to the typhoons of the Indian Ocean and China Seas. And Mr. Thorn has long since shown that the theory holds good for the storms of the Indian Ocean, south of the equator.

EXHIBITION AT MOSCOW

THE Society of Arts has been exerting itself to ensure that England shall take part in the International Exhibition to take place at Moscow next year. At a recent meeting of the Council a deputation was received, consisting of M. Philip Koroleff, Conseiller d'Etat Actuel, Director of the Moscow Agricultural Academy and President of the Educational Department of the Exhibition, MM. Lvoff, Nicholas Saenger, Secretary of the Society of Friends of Natural Science, and the Rev. Basil E. Popove.

M. Koroleff stated that on June 11, 1872, the Society of Friends of Natural Science, Anthropology, and Ethnography, attached to the Imperial University at Moscow, proposes, with the permission of his Imperial Majesty, to celebrate the 200th anniversary of the birth of Peter the Great, falling on that day, by the opening of a Polytechnic Exhibition in Moscow.

This exhibition, which is intended to form the foundation of a Central Polytechnic Museum in the old capital of Russia, and to present, as far as possible, a complete view of the present relations of Natural Science and Technicology to arts and commerce in Russia, as well as of the progress made by the Russian nation in applied sciences throughout a period of two centuries, since the time of Peter the Great, will, in the opinion of Russian naturalists, form a most suitable tribute to the genius of this great historical character, and communicate a more elevated and especially interesting feature to the festival in his honour.

This exhibition is not, strictly speaking, an international one, for, in accordance with its immediate object, it is proposed to limit the number of nations represented in it. The co-operation of German, French, Belgian, and Dutch exhibitors is hoped for, but the desired sympathy and aid is more particularly requested from England, which has attained, in comparison with other nations, such vast and unsurpassed results in that particular sphere, comprising the applications of science to art and commerce, within the limits of which it is proposed to keep the exhibition.

The Applied Natural Sciences and Technicology will form the two great divisions in the exhibition. It is in these two branches of social life that England has given so great an impulse to its own people, and is able to do the same in the case of other nations.

The exhibition is not a commercial undertaking. Its idea has been started, and is being carried out, by men devoted to science and art, who have accordingly based it, not on the principle of competition, but on that of previous invitation, and selection by competent judges.

In view of the proposed formation of a Polytechnic Museum in Moscow, the Committee will also take the necessary measures that articles considered essential to form parts of a systematic collection in it, should be, if possible, secured for the museum.

SOLAR RADIATION TEMPERATURES

IN NATURE of August 24th, page 325, you quote the sun and shade temperatures published by Mr. H. Steward and Mr. F. Nunes, of Chiselhurst, and conclude with the following sentence—"Surely there must be an error somewhere. The maximum temperature of Mr. S. or Mr. N. differ by 40° and 50°! Who is to teach or correct amateur meteorologists?" With your permission I will endeavour (1) to explain the possible cause of these discrepancies, (2) to show that it is to "amateur meteorologists" *alone* that we are indebted for (α) all published information on the subject, and (β) for the inauguration of a system of strictly comparable observations on the temperature of the sun.

The difference between a thermometer in sun and shade may I suppose be roughly defined as due to the excess of the heat rays which penetrate the former beyond those with which it can part. A bright, clear, glass bulb filled with mercury is evidently a mirror; it therefore reflects nearly all the heat rays which fall upon it, and therefore reads nearly the same in full blaze of the sun as in perfect shade. Hence it is useless as a measure of solar heat, and so long back as 1835 it was supplanted by a thermometer of which the bulb was blown in black glass. The next improvement was placing the thermometer inside a glass jacket, which was suggested about the year 1860. The reason for this arrangement was very simple; the naked black bulb thermometer varied with every change of force in the wind, and no two instruments were comparable, because it was impossible to secure precisely similar currents over both thermometers. The glass shields have greatly diminished, but not removed, this source of error. The next improvement was to substitute a dull coating of black for the glassy surface which still acted as a partial reflector. Lastly, it was found that the unblackened stem of the thermometer reduced slightly the temperature of the bulb. Hence we arrive at the present form of instrument, a maximum thermometer, with its bulb and part of the stem dull blackened, enclosed in a glass shield or jacket. Most of them are at present made with nearly all the air exhausted from the shield (whence the term vacuum thermometers), but experiments are in progress with non-exhausted jackets, and that point must therefore be left open.

The difference between one of the earliest and one of the latest form of instruments will reach 60° or 70°.

It was supposed that position did not affect these improved instruments, and so (for example) we have that at Greenwich lying on grass, that at Oxford "in a niche in the west front of the observatory about five feet from the ground."* Some experiments made by myself in 1867 showed that the temperatures on grass depended on the state of the grass, whether succulent or parched, and on its length. Hence it was evident that here again comparability was gone. After many experiments by the Rev. F. W. Stow and others, one of his suggestions was adopted, and the thermometer placed on a post at the same height (4 ft) as everybody (except the Meteorological Committee) places their shade thermometers.

Having thus epitomised the progress of solar temperature observations, I proceed very briefly to the points already mentioned.

(1.) Explanation of the discrepancies.

TEMPERATURE IN SUN DURING AUGUST, 1871

Observer . .	Mr. Steward	Mr. Nunes	Roy. Ob.	Mr. Symons	
Locality. . .		Chiselhurst	Greenwich	Camden Square	
Mode of Observation . . .	Vac.	On Grass	On Grass	On Grass	4ft above ground.
	deg.	deg.	deg.	deg.	deg.
August 7 . .	113	148·0	136·9	127·4	124·5
,, 8 . .	113	147·0	130 5	120 2	123·3
,, 9 . .	110	151 5	142 0	128·5	122·0
,, 10 . .	112	148 0	142·3	124·5	122·3
,, 11 . .	119	150·7	140·0	124·3	118 4
,, 12 . .	115	146·5	146 5	126·4	122 5
,, 13 . .	125	147·0	151·0	128 0	126·2
Mean . . .	122·4	148·4	141 4	125 6	122 7

The instruments and their position at Chiselhurst,

* Radcliffe Met. Obs. 1867, page 4.

Greenwich, and Camden Square, are identical, but the Camden Square grass is by far the most "velvety," and hence partially its much lower temperature. Another and more powerful influence is smoke. Although neither photographers (*e.g.* Mr. F. Bedford) nor artists, (*e.g.* Goodall, R.A., and Cousens, R.A.) deem this a smoky quarter, it is certainly more so than the Royal Observatory, which again is more so than Chiselhurst. Adding 5° to my own readings for the succulence of the grass, we have the following mean values:—Camden 130°6, Greenwich 141°5, Chiselhurst 148°4, whence there appears a regular increase with decrease of smoke. If Mr. Steward's instrument is in the heart of the City, the explanation is complete; but it may differ from the others in construction.

(2.) As this article has become longer than I intended, I will not enter into proof respecting the share in unravelling the inconsistencies of sun temperatures which is due to amateurs, but if required am ready to do so.

Lastly, it is solely to an amateur, the Rev. F. W. Stow, that we are indebted for establishing a small corps of observers in all parts of the British Isles, and some foreign countries, who use only thermometers compared *in the sun*, and mounted on posts so as to be free from terrestrial influences. This is what the private observers are doing, while the public observatories either ignore the subject *in toto*, or follow each its own traditions, and the meteorological societies print indiscriminately readings of thermometers on grass and on posts in jackets, and out of them.

G. J. SYMONS

NOTES

THE arrangements connected with the Eclipse Expedition are making fair progress. The committee have telegraphed to America inviting Prof. Young to take part in the observations. Prof. Zöllner, of Leipzig, has also been asked to join the expedition. We are glad to know that the committee have received the most generous and valuable aid from the directors of the Peninsula and Oriental Steam Navigation Company, and of the British India Telegraph Company. This is as it should be.

IT is hoped that the spectroscope will be brought to bear on Encke's comet this autumn, as the positions will be about as favourable as it is possible for them to be for brightness and a dark sky ground. Mr. Hind informs us that he thought he glimpsed it in Mr. Bishop's refractor a few nights ago.

MR. HIND has communicated a very interesting letter to the *Times* on the solar eclipses of the next twenty years, which we hope shortly to reproduce with some additional facts.

WE have received from the Royal Society of Victoria a prospectus of the proposed Eclipse Expedition from that colony. It states that the Eclipse will be visible as a total Eclipse over a zone about eighty miles wide, passing across the peninsula of Cape York, the Gulf of Carpentaria, and Arnheim's Land to the north of Port Darwin. For the purpose of enabling scientific men in the Australian Colonies to observe the phenomenon, the Royal Society of Victoria proposes to charter a commodious and powerful steamer to carry a party to Cape Sidmouth, or such other point within the limits of totality as may be found most suitable. It is not proposed that the party should be limited to members of the Royal Society, but that it shall be open to the public generally in that and the other colonies. To secure however that no ineligible persons are admitted to the party, the names of all who are desirous to join must be submitted to the Committee appointed for the purpose by the Royal Society. Communications have already been made to the neighbouring Colonies, and many favourable answers have been received. It will be necessary for the expedition to start not later than the last week in November, and it will occupy about three weeks. If possible, arrangements will be made to visit Feejee on the return voyage.

AMONGST the most recent additions to the Zoological Society's living collection, are two specimens of the man-of-war-bird, or fregate-bird (*Fregata aquila*), a well-known denizen of the seas of the Tropics, but one that has never previously reached this country alive. Five of these birds were taken from a breeding-place of this species in the Bay of Fonsecain, Central America, by Captain John M. Dow, C.M.Z.S., of the Panama Railway Company's service, and presented to the society, and two of them have reached the Regent's Park Gardens in excellent health and condition, and may now be seen in one of the compartments of the large Western Aviary. The *Fregata* is an aberrant form of the Pelecanoid type, remarkable for its great powers of flight, and with its structure modified accordingly.

THE new Aquarium at Brighton is now making rapid progress towards completion, some of the tanks being nearly ready to receive their contents. The building is on a very large scale, and will contain upwards of fifty large tanks. Unfortunately, however, no one with any practical knowledge of the working of a large aquarium seems to have been consulted as regards the plans, and there are consequently certain defects in the mode of construction which are likely to interfere with the efficiency of the establishment.

L'ABBÉ MOIGNO, the well-known editor of *Les Mondes*, proposes the establishment of what he terms a "Salle du Progrès," in which an education shall be given which he considers the universities do not supply,—elementary, within the compass of any intelligent mind, and yet of the highest description as to quality. The main feature in the instruction thus given is to be the abundance of experiments and illustrations, whether in any branch of physical or natural science or in art. The illustrative diagrams he proposes to be reproduced on glass by photography, so that they can be packed conveniently in a small box, and then magnified on a large screen by the magic lantern. Admission to the courses at the Salle du Progrès is to be at as low a price as possible, and for the working classes it is to be entirely gratuitous. Under the title of "Daily Bread" (*le pain quotidien*), L'Abbé Moigno proposes also the establishment of a daily journal of religion, politics, science, industry, and literature, intended to promote the regeneration of France by the cultivation of a higher standard than that acknowledged by the bulk of French literature. We wish the Abbé every success, and believe he may do much good by his efforts in these directions. How long are we to wait for scientific lectures for the people in London?

AN International Exhibition of Fruit, open to growers in this and other countries, is to be held in the grounds of the Royal Horticultural Society, at South Kensington, on October 4.

THE recent numbers of the *Révue Scientifique* contain an admirable summary of the most important papers read at the recent meeting of the British Association.

DR. MORTIMER, late head-master of the City of London School, whose death is just recorded, numbered among his pupils, according to the *Pall Mall Gazette*, several men very eminent in science, including Mr. Earnest Hart, and three senior wranglers, Mr. Aldis, Mr. Purkess, and the late Mr. Numa Hartog.

IN Mr. Robert Russell of Pilmuir, who died on the 3rd inst., Scotland has lost one of her most painstaking and scientific meteorologists. A Scottish farmer by birth and training, his whole life was bound up in the agricultural profession. On his favourite study of meteorology, and other subjects connected with scientific agriculture, he was a frequent contributor to various journals, was the author of a work on the Climate and Agricul-

ture of North America, and from 1860 to 1866 was editor of the "Transactions of the Highland Society." He was present at the recent meeting of the British Association, where he read a paper on a branch of meteorology, and was engaged in researches on this subject almost to the time of his death.

THE death is announced of Mr. William P. Turnbull, of Philadelphia, at the age of forty-one This gentleman was born in Scotland, but had resided for a number of years in Philadelphia, where he was well known as an ornithologist of considerable eminence. He occupied himself for a time in collecting a very complete library of works relating to American ornithology and also in securing manuscripts, letters, and original drawings of Alexander Wilson. As an author he was known by the publication of two works; the first, a list of the birds of East Lothian, published in Glasgow; the second, a list of the birds of East Pennsylvania and New Jersey, both of them noted for the beauty of their typography and the accuracy of their indications. He was for many years an active member of the Academy of Natural Sciences in Philadelphia, and his loss will be much felt by that institution.

A THIRD enterprise of the Coast Survey of the United States is that of a hydrographic reconnaissance of the Aleutian Islands and the adjacent coast of Alaska, under the direction of Mr. William H. Dall, so well and favourably known for his previous labours in that country, as embodied in his work entitled "Alaska and its Resources." Mr. Dall is now in San Francisco, and expects to leave in a short time for the field of his operations, to be absent a year or more. He is accompanied by Mr. M. W. Harrington, of Ann Arbor, as astronomer, and goes prepared to carry on the work in all its details, including the preparation of charts, soundings of the bottom, determinations of temperature, the chemical constitution of the water, the deep-sea fauna, &c.

Galignani says that the French expedition to the North Pole with the *Boréal* is about to be carried out, notwithstanding the death of Captain Lambert. The new enterprise has been undertaken by the Geographical Society of Paris. The vessel is at Havre, quite ready to start, and the new chief of the expedition is also, curiously enough, named Lambert.

MR. OCTAVE PAVÉ, a gentleman of French extraction, and, it is said, formerly a resident of New Orleans, has been lately in San Francisco preparing for his proposed visit to Wrangell's Land—an island of which we have already made mention as having been discovered several years ago by Captain Long, to the north-west of Behring Straits, off the coast of Siberia. Mr. Pavé proposes to go to Cape Yokam as the nearest point, and to embark thence in an India-rubber boat for the region referred to This boat is so arranged as to serve as a sledge on land and a boat in the water, and much is expected from its performances. Should Wrangell's Land be reached, the subject of proceeding still farther to the north-west will be entertained, with the idea that possibly a route to the pole may be found in that direction.

A LENGTHENED abstract of Messrs. Hull and Traill's paper on the relative ages of the rocks of the Mourne Mountains, appears in the *Geological Magazine* for September. In the report read at the recent meeting of the British Association, epitomised in our issue for August 24, the granite of Slieve Croob is made to consist of quartz, orthoclase, albite, and mica, instead of quartz, orthoclase, and mica. In the report of the Conversazione in the number for August 17, Dr. Gladstone is spoken of as exhibiting experiments on the crystallisation of metals by electricity, instead of experiments on the crystallisation of silver; the crystalline growth of gold, silver, copper, tin, lead, and zinc by electricity was exhibited under the microscope by Mr. P. Braham.

PROF. HOPPE-SEYLER has recently made an important contribution to our knowledge of the processes of putrefaction and disinfection, and his experiments have a significant bearing on Pasteur's researches. The ferments operated upon were entirely such as are formed of chemical insoluble substances. Liebig's altered views on fermentation, putrefaction, and eremacausis are criticised, and Pasteur's assumption that because living organisms are invariably present in putrefying and fermenting fluids, *therefore* those organism are necessary to, and the cause of, the changes going on, is controverted. It is true, he says, that the organisms may contain the ferment, but it is not the less necessary to separate the ferment from the organism in order to form a correct estimate of the question at issue. The article appeared originally in the *Medizinische-chemische Untersuchungen* for July, and an abstract is given in the *Lancet* for August 26th.

A SENSATIONAL story has been reprinted in the English papers from the *Swiss Times*, with respect to the disappearance of several persons while bathing during the present season in the Lake of Wallenstadt, a circumstance attributed to fishes of enormous size in the lake. Dr. Frank Buckland, while not placing implicit faith in the story, suggests that the obnoxious fish may perhaps be specimens of *Silurus glanis* which have strayed from their accustomed habitat in the Lower Danube, or descendants of the monstrous Kaiserlautern pike mentioned by Conrad Gesner, or perhaps huge carps or mythical creatures existing only in the brains of enthusiastic tourists. More explicit information would be very desirable. This is not the only marvellous fish story. The *New York Tribune*, of August 24, says that a fish mystery is troubling Council Bluffs. Spoon Lake, a placid sheet of water near that city, has never been known to contain fish "to any extent" until recently, when its waters not only swarmed with myriads of finny monsters, but the surrounding shores are alive with fish. They have come in such enormous numbers that the waves wash them high and dry on the shore, where they lie knee-deep, dead and putrefying. The fish trade in Omaha and Council Bluffs has become prodigious. The fish seem to be greatly astonished at their new surroundings, and stick their heads from the water and open their mouths as if they wanted air. A little boy takes a flat board and wades into the water, and in ten minutes throws out as many fish as a waggon can carry, varying in weight from two to five pounds. People who have lived in the neighbourhood for years declare the phenomenon unprecedented, and various wild theories are put forth in explanation. The prevalent belief is that the swarm came into the lake by a subterranean passage during a late storm, while a few venerable observers contend that the Missouri overflowed its banks and flooded the lake with catfish and perch.

A REPORT upon the Bombardment of the Museum d'Histoire Naturelle of Paris, by the German Army in January last, is reprinted from the Bulletin de la Société Botanique de France, by M. Aug. Delondre, and possesses a certain historical interest. It contains details of the destruction wrought among the collections, and a list is given of the stove plants which were destroyed either by the direct agency of the shells or by the effect of the cold to which they were exposed by the destruction of the glass and damage to the houses. The Orchids, Pandaneæ, and Cyclantheæ are among the families which have sustained the most serious injury.

A FIELD DAY in connection with the Newbury District Field Club is to be held on Tuesday, September 19. Highclere and Kingsclere are to be visited, and a lecture will be given during the day by Prof. Rupert Jones, on the Geology of the Kingsclere Valley. The programme includes the visiting of many places of local and antiquarian interest. The first volume of the Transactions of this society is in active preparation, and will shortly be issued.

THE BRITISH ASSOCIATION MEETING AT EDINBURGH

SECTION A.

OWING to the large number of papers still remaining in Section A, the Section was divided on Tuesday into two divisions.

Thermo-Electricity, by Prof. Tait. The principal object of this research was to verify certain deductions which the author had made from the principle of the Dissipation of Energy. But it had also a practical bearing, viz., to obtain a means of measuring high temperature, such as the melting point of iron or rocks. Sir W. Thomson's great investigation had pointed out for the first time that the whole subject of thermo-electricity depended on something more than the ordinary and well-known Peltiet effect; in fact, he predicted and subsequently verified by ingenious experiments the existence of what he called the specific heat of electricity, which, taken in conjunction with the Peltiet effect, supplied a complete explanation of the known phenomena consistent with the Conservation of Energy. His experiments further showed, if the relation between the electromotive force of a thermo-element and the temperature be represented by a curve in which the abscissæ are proportional to the temperature and the ordinates to the electromotive force, that this curve is symmetrical about an ordinate. But they did not show the form of the curve. Some preliminary experiments made by the author of the present paper had shown the curve to be so closely parabolic that he considered the subject worthy of a careful investigation. The difficulty of the research lay not so much in the experiments themselves as in obtaining wires of the infusible metals. He tried circuits of almost every metal which could be obtained in suitable wires, platinum, palladium, iron, &c., and on plotting the results, all the curves appeared to be parabolas. The form of experiment employed was this: As mercurial thermometers were inapplicable to temperatures above 300° C., the simultaneous indications of two separate thermo-electric circuits, the junction wires of which were immersed in the same hot and cold baths, were plotted one as abscissa the other as ordinate. This method gives a very delicate test of the parabolic law; for if the two curves obtained by plotting the two systems separately with the temperatures as abscissæ be exact parabolas, then the curve obtained as above will also be an exact parabola; but, if either of the former differ from the parabolic form, the latter will differ much more. All the results laid down by this method have as yet given very satisfactory approximations to parabolas. The consequences of this parabolic law are curious. If it be admitted, it proves the truth of the author's deduction from the principle of the dissipation of energy, viz., that Thomson's specific heat of electricity, like thermo and electric resistance, varies directly as the absolute temperature. The Peltiet effect is expressed as a parabolic function of the temperature. Another method of combining two thermo-electric circuits is to make the circuits, the junctions being in the same baths, act on a differential galvanometer in opposite directions. It is obvious, from the equations to the parabolas representing the relation of electromotive force to the temperature, or from considering the analogous case of the paths of two projectiles having the same horizontal velocity, and projected from the same point, that, by properly adjusting once for all temperatures the resistances of the two circuits, the term depending on the square of the temperature may be eliminated, and the galvanometer indication will be proportional to the difference of temperatures of the two baths.

Sir W. Thomson, speaking of the importance of Prof. Tait's research, pointed out that its results were in direct contradiction to the statements made in books on the subject.

A New Reflector for Lighthouses, by T. Stevenson.

The novelty of this lantern, which was a holophotal apparatus with a spherical and approximately paraboloidal mirror, combined with a Fresnel's lens, consisted in replacing the speculum which usually forms the mirror by plate-glass facets, silvered, like a looking-glass, at the back.

The paraboloidal mirror consisted of three annular facets formed by the revolution of a circular arc about a horizontal axis, the circular arc osculating the generating parabola to which it was required to approximate.

The facets were prepared at Messrs. Chance's works near Birmingham, by first bending plate glass into the approximate form, and then grinding and polishing the facets in the same way as the prisms of dioptric apparatus are ground and polished. The joints between the facets should be made good with Canada balsam; they can then be hardly seen, as the refractive index of the balsam is nearly the same as that of the glass.

It is sometimes necessary to construct a holophote which shall illumine a given arc of the horizon instead of the whole, as in the ordinary dioptric fixed light, or a very small portion alone, as in the revolving light; in fact, to send out a wedge-shaped beam diverging horizontally. This is usually effected by passing a portion of the light through a second system of prisms to deviate it into the required direction, after being rendered parallel in the usual way. But such a beam could be produced by a single reflection from a suitable surface, and, though it would be impossible to construct such a surface in speculum metal, facets of glass could be made osculating the surface, and be silvered at the back. Mr. Stevenson had asked Prof. Tait for formulæ to calculate the form of surface required.

Prof. Tait exhibited the formulæ he had obtained, and pointed out that such questions could be easily solved by quaternions, and that this calculus was peculiarly adapted to solve the problems of geometrical optics.

A Method of Estimating the Distance of Fixed Stars, by Mr. Fox Talbot.

The author did not know whether he had been anticipated in the proposal of the following method, and he left that to be determined by those better acquainted with practical astronomy.

The principle of the method may be seen from a simple example. Suppose the plane of the orbit of a binary system to pass through the sun, *i.e.* that the observer is in the plane of the orbit, and that in the spectra of the individual stars there are lines belonging to the same element. The spectra of the two stars taken through the same slit should be observed and compared. When the stars appear in the same straight line, it is clear that their velocities relative to the earth are the same, since both are moving perpendicularly to the line of vision; the lines from the two stars will therefore coincide. But when their apparent distance from each other is greatest, the difference of their velocities relative to the observer is equal to the velocity of either star in its orbit about the other. This difference of relative velocity will produce a displacement of the lines, which displacement may be observed and even measured. This will give us the value of that velocity. But we also know the periodic time. We have then at once the circumference and thence the diameter of the orbit. We know the greatest angular distance between the stars; we have then the distance of the stars from the earth.

Report of the Committee on Underground Temperature, by Prof. Everett, D.C.L.

The intended boring at the bottom of Rosebridge Colliery has not been executed, recent occurrences in a neighbouring pit having given the manager reason to fear an irruption of water in the event of such a boring being made. Careful observations of temperature have been taken by the engineers of the Alpine tunnel under Mont Frejus (commonly called the Mont Cenis tunnel). The highest temperature in the rocks excavated was found directly under the crest of the mountain, which is quite a mile overhead. The temperature was 85·1° Fahr., the mean annual temperature of the crest over it being estimated, from comparison with observed temperatures at both higher and lower levels (San Theodule and Turin), at 27·3° Fahr. Assuming this estimate to be correct, the increase of temperature downwards is at the rate of 1° in 93 feet, which, by applying a conjectural correction for the convexity of the surface, is reduced to about 1° in 81 feet as the corresponding rate under a level surface. This is about the rate at Dukenfield Colliery, and is much slower than the average rate observed elsewhere. The rocks are extremely uniform, highly metamorphosed, and inclined at a steep angle. They contain silica as a very large ingredient. They are not faulted to any extent, and are very free from water. It is proposed to sink two bores, to the depth of from 50 to 100 feet, at the summit, and another point of the surface over the tunnel, with the view of removing the uncertainty which at present exists as to the surface-temperature. Mr. G. J. Symons has repeated his observations at every fiftieth foot of depth in the water of the Kentish Town well, between the depths of 350 and 1,100 feet, the surface of the water being at the depth of about 210 feet. The observations which have been repeated are thus completely free from the disturbing effect of seasonal changes. The results obtained agree closely with those previously found, and show between these depths a rate of 1° in 54 feet, which, from the estimated mean temperature of the surface of the ground, appears to be also very

approximately the mean rate for the whole 1,100 feet. The soil, from 325 to 910 feet of depth, consists mainly of chalk and marl, and shows a mean rate of 1° in 56 feet. From 910 to 1,100 feet, it consists of sandy marl, sand, and clay, and shows a mean increase of 1° in 54 feet. The former of these is in remarkably close agreement with very trustworthy determinations made by Walferden from observations in the chalk of the Paris basin. These are as follows:—Puits de Grenelle, Paris, depth, 400 metres; rate, 1° F. in 56·9 feet. Well at Military School, Paris, depth, 173 metres; rate, 1° F. in 56·2 feet. Well at St. André, 50 miles west of Paris, depth, 263 metres; rate, 1° F. in 56·4 feet. General Helmersen, of the Mining College, St. Petersburg, informs the secretary that, in sinking a well to the depth of 540 feet at Yakoutsk in Siberia, the soil was found to be frozen, probably to the depth of 700 feet. The rate of increase from 100 to 540 feet was 1° F. in 52 feet. A new pattern of thermometer has recently been constructed for the committee, which promises to be of great service. It is a maximum thermometer on Negretti's principle, adapted to be used in a vertical position with the bulb at the top. The contraction in the neck prevents mercury from passing into the stem when the instrument receives moderate concussions. Before taking a reading, the instrument must be gently inclined so as to allow all the mercury in the stem to run together into one column near the neck. On restoring the thermometer to the erect position, the united column will flow to the other end of the tube (that is, the end furthest from the bulb), and it is from this end that the gradations begin. It is set for a fresh observation by holding it in the inverted position, and tapping it on the palm of the hand. This instrument, like that heretofore used by the committee, is protected against pressure by an outer case of glass, hermetically sealed.

SECTION G.

AT the opening of this Section on Monday, after disposing of Mr. Symons' Report of the Rainfall Committee, a paper *On a New Form of Steam Blast*, was communicated by Mr. W. Siemens, F.R.S. The new blast is employed for the movement of air in the pneumatic tubes connected with the central telegraph station in London. It is said to cost only 40*l*., and will do the same work as an engine which costs 2,000*l*.

Mr. Stevenson then read a paper describing what he termed a *Thermometer of Translation*. It consists of an expansible body, with needle point at its upper end, and when expanded by the sun is fixed at its upper end, by a needle point catching into fine teeth cut in a sheet of glass or other material of small expansibility pressed below. The end being fixed, the contraction raises the centre of gravity at the bar. In this way the daily march or creep of the bar chronicles the changes of temperature.

Mr. Michael Scott, in a paper *On Improved Ships of War*, proposed to construct a ship of war, which should combine cruising and fighting qualities, by adopting the turret system for the guns, and having the ship so designed that the free board could be reduced by sinking her deep in the water through the filling of certain cisterns. The masts were to be of telescopic construction.

Captain Jenkin, C.B., said this was a subject of grave importance to the country. He thought, however, it would be necessary before giving an opinion on this paper, that they should be able to understand what, in the proposed ship, was intended to be below the water. All he (the speaker) could see was what was to be above the water, and consequently he could not give an opinion in a professional point of view on the plans produced. While Mr. Scott was entitled to their thanks for what he had produced, he thought it would be necessary for him to bring forward models of the ships he proposed to construct.

A paper *On an Apparatus for Working Torpedoes* was read by Mr. Philip Braham. The author proposed to propel or "shoot" torpedoes against the enemy's ship by means of compressed air, and under the surface of the water.

On Tuesday, the reports on the treatment and utilisation of sewage read in the Chemical Section on Monday having been submitted, a paper on *The Carbon Closet System* was read by Mr. E. C. C. Stanford, F.C.S. In the most populous places the carbon system, he held, was the most practicable, the most healthful, and the most profitable means that could be used in getting rid of the sewage; and he thought that the system of the future must be some modification of the dry system such as that which he had brought before the section. An interesting discussion followed the reading of this paper.

The committee appointed to consider the various plans proposed for legislating on the subject of Steam-boiler Explosions, with a view to their prevention, presented an interim report, in which they stated that the Parliamentary report having been so recently published, there had not been time for its due consideration, or for the committee to meet and confer thereon, and they had postponed entering into the subject on the present occasion.

Mr. Lavington E. Fletcher, C.E., in a paper on *Steam-boiler Legislation*, stated that the Parliamentary Committee had arrived at the three following conclusions, viz.:—(1) That the majority of explosions arise from negligence, either as regards original construction, inattention of users or their servants, neglect of proper repairs, and absence of proper and necessary fittings; (2) that on the occurrence of explosions, a complete investigation of the cause of the catastrophe should be promoted by the appointment of a scientific assessor to assist the coroner; and (3) that reports of each investigation should be presented to Parliament. These three conclusions, it was considered, formed a foundation from which a superstructure would spring in course of time which must eradicate steam-boiler explosions. What the precise character of that superstructure should be is a question on which opinions may differ. Some—among whom are the Parliamentary Committee as already explained—prefer a system of pains and penalties to be inflicted on the steam user in the event of his allowing his boiler to give rise to an explosion. Others prefer a system of direct prevention by the enforcement of inspection on the following general basis:—They would recommend a national system of periodical inspection enforced but not administered by the Government, that administration being committed to the steam users themselves, with a due infusion of *ex officio* representatives of the public. For this purpose they propose that steam users should be aggregated into as many district corporations as might be found desirable, boards of control, empowered to carry out the inspections, and levy such rates upon the steam users as might be necessary for the conduct of the service, being appointed by the popular election of the steam users in each district, the different boards being affiliated by means of an annual conference, in order to promote the harmonious working of the whole system. Its advocates consider that in this way a system of national inspection might be mildly, but, at the same time, firmly administered, and that it would then not only prevent the majority of steam boiler explosions, but prove of great assistance to steam users in the management of their boilers. That it would be the means of disseminating much valuable information. That it would promote improvements. That it would raise the standard of boiler engineering, and prove a national gain. It frequently happened, the paper went on to say, that on the occurrence of disastrous explosions, boiler owners were quite unable to compensate those who had been injured. Such was the case last year at Liverpool, where an explosion occurred at a small iron-foundry, in October, killing four persons, laying the foundry in ruins, smashing in some of the surrounding dwelling-houses, and spreading a vast amount of devastation all round. The owners of the boiler, which had been picked up second-hand, and was a little worn-out thing, were two working men, who but a short time before the explosion had been acting as journeymen. They were possessed of little or no capital, and were rendered penniless by the disaster. Another very similar case, though much more serious, occurred at Bingley in June 1869, where as many as fifteen persons were killed, and thirty-one others severely injured by the explosion of a boiler at a bobbin turnery. In this case the user of the boiler was only a tenant, and, judging from the ruined appearance of the premises after the explosion, any attempt to gain compensation for the loss of fifteen lives and thirty-one cases of serious personal injury would be absolutely futile. The plan of imposing a fixed minimum penalty would tend somewhat to meet this difficulty, as the surplus of one would correct the deficit of another, and in this way a compensation fund might be established for the benefit of the sufferers. This definite minimum penalty would tend to meet the present tendency of boiler owners to seek to purchase indemnities from insurance companies in the event of explosions, rather than competent inspection to prevent these catastrophes, since, if the penalty were made sufficiently high, it would pay an insurance company as well to make inspections and prevent explosions, as to adopt comparatively little inspection, permit occasional if not frequent explosions, and pay compensation.

A short discussion took place, in which it was argued that increased security for the proper inspection and manufacture of boilers should be obtained.

The last paper read in this Section was *On the Rainfall of Scotland*, and contributed by Mr. Buchan. The paper was illustrated by a map of Scotland, showing the average annual rainfall of about 200 places, many of the averages being deduced from observations carried on through a long series of years. The map brought out the large rainfall in the west as compared with the east, a difference which was strongly marked even in the group of the Orkney Islands. The average rainfall in the west, at stations removed from the influence of hills, was from thirty-six to about forty inches; but on the east coast, in similar situations, the rainfall was as low as from twenty-four to twenty-eight inches. In casting the eye towards the watershed of the country running north and south, it was seen that in ascending towards it from the west, there occurred a rapid, but by no means uniform, increase; and in descending from it towards the east, a rapid, but by no means uniform, decrease. The largest rai falls occur almost wholly among the hills forming the watershed north of the Forth and Clyde. The places characterised by the heaviest rainfall are, so far as observation has yet enabled us to determine, the following:—Glencoe, immediately under Rest-and-be-Thankful, 128 inches annually; Ardlin, head of Loch Lomond, 115 inches; Bridge of Orchy, 110 inches; Tyndrum, 104 inches; Glen Quoich, in the south-west of Invernesshire, 102 inches; and Portree, Skye, 101 inches. At no great distance from several of these places the rainfall is by no means excessive, thus pointing out an enormous difference of climate between places not far apart. Along the watershed of that part of Scotland which lies south of the Forth and Clyde, no such excessive rainfall occurs, the highest hitherto observed being only 71 inches, Ettrick Pen Top, 2,268 feet high. This diminished rainfall in the south as compared with places similarly situated further north is doubtless due to the mountains of Ire and to the south-west, which partially drain the rain-bringing winds of their moisture before they arrive at these parts of Great Britain. The distribution of the rainfall is very instructive in many districts, as in the valley of the Forth, from the head of Loch Katrine to North Berwick, where the amount varies from ninety-one to twenty-four inches; in Clydesdale, where the quantity is greatest at the head and foot of the valley respectively, being considerably less at intermediate places; and along Loch Linnhe and through the Caledonian Valley, where the variations of the rainfall were excessive. In all these districts, as well as elsewhere, many cases might be referred to, showing that the amount of the rainfall is very far from being determined by mere height. In truth, it is to local considerations we must chiefly look for an explanation of the mode in which rain is distributed over any district; and hence, in estimating the rainfall, particularly in hilly districts, no dogmatic rule can be laid down which can approximate in accuracy the result arrived at by one skilled in such matters and who is at the same time well acquainted with the district. If those districts were shaded off in which the rainfall did not exceed 30 in annually, the great grain-producing district of Scotland would be indicated; and it was interesting to note that in those districts which produced the best wheat the rainfall was lower than elsewhere, being in many places as low as 24 in. There are about fifty places at which observations have been made for periods varying from twenty to forty-five years. On comparing the average of the three driest years at each of these places with its average, the amount of the deficiency is found to vary exceedingly, being as much as one-third in some places and as little as one-ninth in others.

Mr. Bateman expressed his great satisfaction that Mr. Buchan had stuck to facts instead of theorising. He went on to say that the correction given for the three dry years was just as fallacious as the correction for altitude. A proposed rule had been laid down of an increase in the rainfall of one and a half per cent. for each 100 feet of elevation, but subsequently that one and a half had been changed to two and a half. Mr. Bateman said that the formula for the three dry years was that for the height. In point of fact it was impossible to lay down any rule that would give accurate results.

Mr. Symons drew attention to the fact that the ratio of the three dry years depended very much on the length of period involved, and showed that the epoch of dry years in the instances quoted varied almost precisely with the length of those averages.

Mr. Bateman and Mr. Symons spoke strongly in favour of the work performed by Mr. Buchan, and of the excellent operations of the Scottish Meteorological Society.

Mr. Milne Home made a few appropriate remarks in reply.

MAXIMUM VELOCITY OF METEORIC STONES REACHING THE SURFACE OF THE EARTH

IN Prof. Nordenskjöld's account of the Aerolitic Shower which took place near Hessle, in Sweden, on the 1st of January, 1869, he mentions, as a remarkable fact, that stones weighing two pounds, which struck the ice of the Larsta-Viken, failed to penetrate, making holes only three or four inches deep in the ice and rebounding. (Vide the *Academy*, Dec. 15, 1870.)

The small velocity retained by these stones at the time of striking the earth is, doubtless, owing to the resistance of the air, and, consequently, is not an indication of the velocity which they had upon entering the atmosphere.

Stones thus penetrating the atmosphere from interplanetary space, would be moving in a resisting medium under the joint influence of their original velocity of translation and the constant action of terrestrial gravity. In the case of small masses, the resistance of the medium would very speedily produce retarded motion; and before traversing twenty or thirty miles of air, they would probably move with a velocity approximating uniformity, and under the action of gravity alone. In other words, they would gradually lose their original velocity of translation, and, descending, nearly or quite vertically, under the action of gravity, would ultimately attain a maximum velocity under the opposing influences of the resisting and accelerating forces, and then descend to the earth with this uniform velocity.

Thus, for example, a rifle bullet shot obliquely into deep water, would very soon lose the horizontal component of its velocity, while the vertical motion would be so rapidly retarded that, at a comparatively short distance below the surface of the water, it would begin to descend vertically with the very moderate uniform motion resulting from the resistance of the liquid and the constant action of gravity.

In like manner, no matter how great the velocity with which a meteoric stone enters the atmosphere, the enormous resistance which it encounters must operate ultimately to produce a similar result, although, in some cases of oblique incidence, the horizontal component of velocity is not entirely lost before reaching the earth.

It is well known that this maximum or limiting velocity of a falling body is attained when the required velocity is such that the resistance is at each instant equal to the weight of the moving body. In the case of small masses moving in the air, it may be shown that this velocity is quite moderate.

The principles of dynamics furnish the means of determining the resistance of a given body moving in a medium of given density when the size of the body and its velocity are known.

Let A = area of cross-section of body at right angles to direction of motion.
D = weight of unit volume of medium (air).
v = velocity of moving body (meteoric stone).
g = acceleration by gravity in a unit of time.
k = a constant co-efficient, deduced from experiment, depending upon the shape of the moving body.

Then we have,

$$\text{Resistance} = k \times A \times D \times \frac{v^2}{2g}$$

Hence, by the conditions under which, as above given. v becomes a maximum, if w = weight of the moving body or stone, we have,

$$k \times A \times D \times \frac{v^2}{2g} = w \therefore v = \sqrt{\frac{2g \times w}{k \times A \times D}} \qquad (a)$$

Applying this formula (a) to the case of a meteoric stone weighing two pounds moving in the air:—let us assume it to be a cubical mass, having a specific gravity of 3 in relation to water as unity. Then its volume = 18·482 cubic inches, and the area of one of its faces = 6·9903 square inches = 0·048544 square feet. Hence, assuming the resistance to act at right angles to the face of the cube, and taking the pound and foot as units, we have—

A = 0·048544 square feet.
D = 0·0807288 pounds = weight of cubic foot of air at 0° C.
w = 2 " = " " stone.
g = 32·1928 feet per second.
v = required maximum velocity in feet per second.

Hence by formula (*a*) :—

$$v = \sqrt{\frac{2 \times 32\,1928 \times 2}{k \times 0.048544 \times 0\,0807288}} = \sqrt{\frac{128{\cdot}77}{k \times 0{\cdot}0039189}}$$

$$= \sqrt{\frac{32859}{k}}.$$

Or $v = \frac{181{\cdot}27}{\sqrt{k}}$ in feet per second.

Assuming $k = 1{\cdot}3$,* we obtain,

$v = 158{\cdot}99$ (= 159) feet per second, as the maximum velocity attained by such a stone in falling to the earth. This velocity does not exceed *one-tenth* of the initial velocity of a rifle bullet. And, as the *penetrating power* of a given projectile is proportional to the *square* of its velocity, its power of penetrating the ice would only be *one-hundredth part as great* as that of a projectile of similar mass and dimensions moving at the rate of a rifle bullet. Hence *we need not be surprised that the ice was not penetrated more than three or four inches.*

If the same mass of stone (two pounds) were *spherical* in form instead of *cubical*, its diameter would be 3·2803 inches = 0·27336 feet, and $A = 0{\cdot}058689$ square feet. In this case, we may assume $k = 0{\cdot}7$ † Hence, by the formula (*a*), we obtain,

$v = 197{\cdot}05$ feet per second: so that in this case likewise its velocity would be quite low, and its penetrating power *very insignificant.*

Of course, in the case of *large* meteoric stones the value of v would be much greater. JOHN LE CONTE

ASTRONOMY

The Solar Eclipse of 1868 ‡

ADEN was chosen as the observing-station because from the general nature of its climate it was thought that a satisfactory view of the phenomena that took place during the eclipse might fairly be expected, and also because, as it was far removed from the stations of the French and English expeditions, any observations taken there would prove of considerable importance. The observers were Prof. Edmund Weiss (the leader) Prof. Oppolzer, and J. Rziha, already known for his observations of the eclipse of 1867.

On the morning of the eclipse (Aug. 17) the state of the atmosphere proved unfortunately anything but favourable for astronomical investigation, owing to the presence of a great amount of cloudiness. According to Oppolzer the beginning of the totality was $18^h\ 29^m\ 30^s{\cdot}0$ (Aden mean time), the end $18^h\ 33^m\ 24^s{\cdot}6$.

A few moments before the total disappearance of the sun, Weiss saw on it a beautiful carmine red border or streak, in the middle of which arose a semi-arc-coloured complicated prominence (No. 1) which lasted for a few seconds. Half a minute later ($18^h\ 3^m\ 2^s$) a second prominence (No 2) appeared, long, thin, and in shape resembling a slightly bent finger; nearly two minutes later ($18^h\ 31^m\ 58^s$) he noticed a third smaller, hill-shaped, or conical prominence (No. 3). Just at the end of the totality another beautiful red border appeared, on the outer edge of which was a gleam of deep blue, most intense at the point of junction with the red, and rapidly fading away on the outside into the background.

Some English officers stationed a short way off also noticed the first two prominences (which they say were visible to the naked eye) and the red border at the end of the totality, but they failed to see prominence No. 3, perhaps for want of sufficiently powerful or properly adapted instruments.

Oppolzer's observations coincided with those of Weiss, except that he failed to see prominence No. 3 on account of the interference of passing clouds, though he suspected its presence from a certain red appearance at the spot indicated by Weiss. Satisfactory observations of the corona were rendered impossible by the state of the atmosphere.

Rziha's part was confined to the spectrum, and his account is that simultaneously with the disappearance of the last sunbeam. Fraunhofer's lines entirely vanished, the spectrum became continuous and remained so to the end of the totality. All his efforts to detect any reversal of the lines proved ineffectual. Just before the reappearance of the sun, thin clouds intervened and hid the greater part of the corona, so that the principal sources of light were the red border and the prominences. At this moment the more refrangible rays from the green disappeared gradually, and only the red end of the spectrum remained, consisting of deep red, carmine, orange, feeble yellow, and the faintest possible tinge of green, at the same time this remaining part became discontinuous owing to the appearance of dark lines in it, which did not, however, coincide with any of the principal lines of the ordinary spectrum. The disappearance of the dark lines, Rziha seems to think, would connect the corona with a solar atmosphere; and he suggests that the lines or streaks which appeared afterwards were due to absorption by the water-vapour of our own atmosphere.

PHYSICS

On a Quantitative Method of Testing a "Telegraph Earth," by W. E. Ayrton*

THE method used up to the present time for testing a telegraph earth has been *qualitative* only. As, however, the electrical condition of every "earth" is of great practical importance, it is necessary that some accurate *quantitative* method should be devised, in order that every telegraph office may ascertain whether the resistance of their earth is higher or lower than the maximum resistance allowed. The principal difficulty met with is that, if the resistance between two earths be measured successively with positive and negative currents, the same result is not obtained. Consequently the ordinary law for a Wheatstone's Bridge, or Differential Galvanometer, would not hold true. This difficulty, however, has been overcome in this paper, and formulæ are developed suitable for a Wheatstone's Bridge, a Differential Galvanometer, or a Galvanometer of which the law of the deflections is known.

The details of some experiments are also given, and a particular instance is mentioned in which a much better "earth" was obtained by burying the plate in the upper stratum of soil than by burying it much deeper, on account of a bed of sandstone that existed at about fifteen feet below the surface.

SCIENTIFIC SERIALS

THE *American Naturalist* for September commences with an article by Mr. W. J Hays, entitled "Notes on the range of some of the Animals in America at the time of the arrival of the white men." The moose, now almost entirely driven out of the United States, was, at the time of the first European settlement, found as far south as New York city; the range of the carriboo was not more extensive then than it is now, although fossil remains have been found as far south as the Ohio; the musk-ox is not mentioned by the early travellers; but the common deer (*Cervus virginianus* and *C. campestris*) was everywhere represented as existing in incredible numbers. The Wapiti deer was found all along the coast from Canada to the Gulf of Mexico; the bison (improperly called the buffalo by the early settlers), also ranged along the coast from the valley of the Connecticut to Florida and roamed over the entire country now known as the United States, and extending as far north as the sixtieth parallel in British America. Mr. Hays reckons that at the present time not fewer than half-a-million bisons are annually destroyed by the hand of man. The red fox existed in America before the advent of the white man, in addition to the gray species, notwithstanding assertions to the contrary; wolves were everywhere abundant, as also was the beaver; the jaguar, not now found east of Texas occurred in the mountains of North Carolina as recently as 1737; the dog was found in all parts of the country; and, from the descriptions, must have been of the same species as those now found with the Indians of the plain. The only other original article in the number is "On the Food and Habits of some of our Marine Fishes" by Prof. A. E. Verrill.

THE most important paper in the *Journal of Botany* for September is an article by Mr J. G. Baker "On the Dispersion of Montane Plants over the Hills of the North of England." Mr.

* For *cubes* moving in *water* the experiments of Du Buat and Duchemin give $k = 1{\cdot}28$.

† For *spheres* moving in *air* the experiments of Robins and Hutton give for velocities :—

$v = 3{\cdot}28,\ 16{\cdot}4,\ 82,\ 328$ feet per second.
$k = 0{\cdot}59,\ 0{\cdot}63,\ 0{\cdot}67,\ 0{\cdot}71.$

‡ *Astronomische Nachrichten*, No. 1836-1837: "Account of the observations of the Austrian Expedition sent to Aden to watch the total solar eclipse of 1868."

* From the Proceedings of the Asiatic Society of Bengal.

Baker divides the sub-mountainous regions of the North of England into four distinct ranges:—the Porphyritic Hills, including the Cheviots; the Carboniferous Hills, or that portion of the Pennine chain which falls between the Tyne and the Wharfe; the Slate Hills of the Westmoreland and Cumberland Lake district; and the Oolitic Hills of North-east Yorkshire. The range of each indigenous species of sub-alpine plant is traced, and a comparative table given of the number of species found in each range; those in the Slate and Carboniferous districts more than doubling those in the Porphyry and Oolite. Dr. Trimen contributes a description, with plate, of *Siler trilobum*, an alleged new British plant, the genuinely indigenous character of which is, however, questioned.

SOCIETIES AND ACADEMIES

PARIS

Academie des Sciences, September 4.—M. Faye in the chair.—M. Bertrand read a long note on the theory of the moon. The learned member supported the same theory as the one advocated by M. Biot, and contended that the third of the three great lunar inequalities had been discovered by Ptolemy. M. Sedillot, a learned Arabic scholar, is of the contrary opinion, and his views were successively supported by M. Leverrier and M. Chasles.—Father Secchi sent from Rome the result of observations made with the same instruments as those he had previously made, and which, having been executed up to the 26th of August, during a period of magnificent weather, are of special interest. An engraving, which is necessary for their comprehension, is sent for publication in the *Comptes Rendus*. It shows the sun as it was observed on the 23d of July from 8.30 to 9.40 at Rome; protuberances are seen, as exhibited by spectroscopic observations. They are very great in number as well as in dimension. Father Secchi says that he is now engaged in making special observation, to ascertain if variations observed in the number and form of protuberances are not connected with variations in the photosphere, and, consequently, with the diameter of the sun itself. Father Secchi states, moreover, that it is very difficult to account for the differences between several accurate observers, which amount to two seconds, without some elements of the kind. He said that he will very soon send a special paper on this important matter. M. Faye, in review of the paper, said that great discoveries might be expected very shortly relatively to the constitution of the sun, and that the labours of various contributors to this subject might be very shortly rewarded.—M. Chasles presented to the Academy a book sent by M. Quetelet, Director of the Royal Brussels Observatory, entitled "Anthropometry; or Measurement of the different Human Faculties." The author tried to find curves, exhibiting not only muscular force and vitality, but also the vices and virtues, representing the period of life at which the proclivities are the strongest for murder, robbery, love, &c. &c.—M. de Tastes sent a paper "On the Atmospheric Currents of the Northern Hemisphere," which, if grounded on facts, may help to prognosticate the weather. He supposes that the polar regions are not disturbed by storms, but are regions of calm. In order to support his theory he quotes a letter sent to the Academy in July 1870, in which he wrote these words, "the next winter, 1870-71, will be one of the coldest in the whole century."—M. Dumas read a note from MM. Troost and Hautefeuille founded on the memoir published by M. Morren on the spectrum of carbon in the Ann. Phys. et Chemie (4th ser., vol. iv., p. 365), and several other accurate spectroscopic determinations. The authors endeavoured to show that the spectra of carbon, boron, silicon, titanium, and zirconium may be derived from each other by special and gradual modifications indicative of certain secret affinities or rather analogies in the form of the molecules. An analogous series was established by M. Ditte for the spectra of sulphur, selenium, and tellurium. M. Dumas suggested whether each natural chemical family cannot be expected to show some spectroscopic affinities for its different members.

MELBOURNE

Royal Society of Victoria, April 17.—Mr. Foord read some notes on the enhydros or water stones, and described the result of experiments upon a sample weighing over 900 grains, which he had obtained through Mr. Ulrich from Mr. Dunn, the mineralogist, who was the discoverer of these stones in Victoria. The sample had for its largest section a form closely approaching an equilateral triangle. It clearly included two separate chambers; in fact, during the experiment it was cloven into two separate water stones one of which appeared to be quite filled up with quartz crystal; the other containing, besides an inner lining of quartz, a mobile fluid and a bubble of air. To extract the fluid, a fragment was broken from one of the corners of the stone. This disclosed a fine opening or pore in the quartz lining connected with the inner gravity. The fluid was perfectly pellucid, but contained a few minute angular transparent fragments. The fluid was water, slightly mineralised. A single drop evaporated on glass left a slight residue, forming a gummy annular outline, but affording distinct evidence of crystallisation when examined under the microscope. When fifteen drops of the fluid were evaporated on a watch-glass over oil of vitriol, in vacuo, the fluid froze, giving out air bubbles, which vesiculated the icy crust; the ice gradually disappearing left a small residue, nearly white in colour, now crystalline and wrinkled on the surface. A few small crystals and some large ones were observed in the mass. A small crop of beautiful microscopical crystals were obtained on resolution and spontaneous evaporation. Among them were recognised cubic crystals and crystals pertaining to the cubic system. On dissolving the crystals a delicate impress of their form was left, white on a delicately pale yellow ground, as though a deposit of colloidal ferruginous silica remained, with colourless cavities where the crystals had occupied position. On testing the re-dissolved saline matter, it gave a distinct white flocculent precipitate with nitrate of silver, immediately soluble in ammonia. It also gave a granular precipitate with chloride of barium. With ammonia and oxalate of ammonia a very slight granular precipitate was obtained after some time, and with ammonia, chloride of ammonia, and phosphate of soda, relatively abundant crystalline precipitate tufts, or stellate groups of acicular crystals, were obtained. A drop of the fluid examined in the microscope showed vividly the sodium double line, but no indication of potassium, lithium, calcium, nor indeed of any other metal, was apparent. Having thus described the result of his experiment, Mr. Foord endeavoured to show that the wall of the enhydros owed its plane form to crystalline silica deposited along with the amorphous silica, the two together forming the chalcedony. It was also attempted to be shown that there was every gradation from agate, in which the deposit was on the wall of the cavity like a varnish, up to enhydros, in which the cavity was interlaced by planes dividing it into angular chambers. Specimens of thin laminæ were shown, in which the crystalline character of quartz was distinctly observable, resembling the geometric carpet pattern. The President again brought under the notice of the Society the proposed expedition to Cape York in December next, to view the Total Eclipse of the sun, to the preparations for observing which we have already alluded.

BOOKS RECEIVED

ENGLISH.—Phrenology; and How to Use it in Analysing Characters: N. Morgan (Longmans).—Hints on Shore Shooting: J. E. Harting (Van Voorst).—Modern Scepticism: C. J. Ellicott (Hodder and Stoughton).—The Phœnix; vol. i., and vol. ii., No. 13.

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