on this subject by no means exhaust it; but I think it may be safely asserted that selection has yielded much more than sports.

W. BOTTING HEMSLEY.

Prof. Milne's Observation of the Argentine Earthquake, October 27, 1894.

A FEW days ago I received from Prof. Milne a letter, dated March 15, 1895, in which he sends me a list of earthquake disturbances, compiled from the records he was fortunate enough to rescue from the fire which destroyed his house on February 17. In this list I find no less than three observations of the great Argentine earthquake of October 27, 1894, which was recorded by three different horizontal pendulums. The times given for the beginning of the earthquake—viz. 18h. 10m., 18h. 5m., 17h. 41m.[1]—are not very trustworthy, because they were determined by measuring the linear distance from a break in the curve which was caused regularly every day about noon by taking away the lamp. The exact times of these breaks were noted in a book, which, unfortunately, was destroyed by the fire. Prof. Milne, however, tells me that in the instrument, to which corresponds the first of the above-mentioned times, the lamp was always removed within half a minute or one minute from noon (Japan time). Consequently, the error cannot exceed a few minutes. The duration of the disturbance was between two and three hours in all the three instruments.

If we consider that the error of the first observation is not likely to exceed ten minutes, then we find, by comparing Prof. Milne's observations with those made in Europe, that although the spherical distance between the epicentre of the earthquake and Tokio is *no less than* 17,400 *kilometres*, the earth-motion reached Japan at about the same time, or perhaps even a little earlier, than it arrived in Europe. It is unnecessary to point out the interest which is attached to systematic observations of this kind. Prof. Milne's observation is probably the first in which an earthquake was noticed by seismic instruments at a place so near the antipodes of the earthquake centre. A straight line between the two points is only very little shorter than the earth's diameter; the time required for the motion to pass through the globe was probably less than twenty minutes.

Merseburg, May 1. E. VON REBEUR-PASCHWITZ.

Guanine in Fishes' Skins.

IN a joint paper by Mr. J. T. Cunningham and myself (*Phil. Trans.* vol. clxxxiv., 1893, B, pp. 765–812), we have ventured to question the accuracy of the statement made in many text-books of physiological chemistry, that guanine occurs in combination with calcium in the skin of fishes. We found that the guanine occurs in the free state. In the last number of Hoppe-Seyler's *Zeitschrift für Physiologische Chemie* there is a paper by Herr Albrecht Berthe, dealing with this subject, in which he shows that the calcium so frequently found with the guanine is due to the presence of impurities derived from the tissues and the scales. Its amount depends upon that of the impurities present, and is very variable. Instead of finding 11·76 per cent. required by the formula of "*Guaninkalk*," Berthe finds less than one-third of that percentage present, and even this also varies within wide limits. In the paper referred to above, we found one source of the calcium was due to the presence of comparatively large crystals of calcium phosphate, which are figured on p. 788; but there is no doubt that the bulk of it is derived from the scales.

CHAS. A. MACMUNN.

Oakleigh, Wolverhampton, May 4.

The Oldest Vertebrate Fossil.

NOTICING in your issue of April 11 a reference to the discovery of specimens of *Cyathaspis* in the Silurian of Gotland in strata equivalent to the English Wenlock, and with it the statement that these fossils are "for the present the oldest known vertebrates," I am led to call your attention to the species described by myself from Silurian strata in Pennsylvania in 1885 (p. 48), and again in 1892 (p. 542), in the *Quarterly Journal* of the Geological Society. I forward with this a copy of the paper, from which it will be seen that the Salina (Ononduga) beds that yielded *Palæaspis* are older than the Ludlow (or Lower Helderberg), and that the Clinton are older than the Wenlock (or *Niagara*). Consequently *Onchus Clintoni* of the latter group is thus far the oldest vertebrate. E. W. CLAYPOLE.

Akron, Ohio.

[1] These hours are Japan time, *i.e.* 9h. east of Greenwich, and are reckoned from noon.

TERRESTRIAL HELIUM.

SINCE our last reference to this subject three communications have been laid before the Royal Society. They are as follows:—

HELIUM, A GASEOUS CONSTITUENT OF CERTAIN MINERALS.[1]

An account is given of the extraction of a mixture of hydrogen and helium from a felspathic rock containing the mineral clèveite. It is shown that in all probability the gas described in the preliminary note of March 26 was contaminated with atmospheric argon. The gas now obtained consists of hydrogen, probably derived from some free metal in the felspar, some nitrogen and helium. The density of helium, nearly free from nitrogen, was found to be 3·89. From the wave-length of sound in the gas, from which the theoretical ratio of specific heats 1·66 is approximately obtained, the conclusion may be drawn that helium, like argon, is monatomic. Evidence is produced that the gas evolved from clèveite is not a hydride, and a comparison is made of the spectra of argon and helium. There are four specially characteristic lines in the helium spectrum which are absent from that of argon: they are a brilliant red, the D_3 line of a very brilliant yellow, a peacock-green line, and a brilliant violet line. One curious fact is that the gas from clèveite, freed from all impurities removable by sparking with oxygen in presence of caustic potash, besides other fainter lines, exhibits one, and only one, of the characteristic bright red pair of argon lines. This, and other evidence of the same kind, appears to suggest that atmospheric argon and helium have some common constituent.

Attention is drawn to the fact that on subtracting 16 (the common difference between the atomic weights of elements of the first and second series) from 20, the approximate density of argon, the remainder is 4, a number closely approximating to the density of helium; or, if 32 be subtracted from 40, the atomic weight of argon if it be a monatomic gas, the remainder is 8, or twice the density of helium, and its atomic weight if it too is a monatomic gas.

ON THE NEW GAS OBTAINED FROM URANINITE.[2]

Since my communication on the gas obtained from Uraninite (Bröggerite) was sent in to the Society on the 25th ult., I have been employing the method I there referred to in several directions, among them to determine whether the spectrum of the gas indicates a simple or a complex origin.

I was led to make this special inquiry on account of the difference in the frequency of the appearance of D_3 and the other lines to which I referred in the solar chromosphere. For instance, if we take the lines D_3, 4471, and 4302, the frequencies are as follows, according to Young[3]:—

D_3	100	(maximum)
4471	100	,,
4302	3	

Hence, we might be justified in supposing that D_3 and 4471 are produced by the same gas, and that 4302 owes its origin to a different one.

But further experiment has given me one case in which D_3 shows bright, while 4471 is entirely absent. I may now add that an equally important line to 4471, one at 4026·5, appears, with the dispersion employed, in the spectrum of Bröggerite, and both these lines are wide and fluffy, like the lines of hydrogen, and are apparently reversed.

The line 4026·5 has not been recorded by Young, though, as I have stated, the frequency of appearances of 4471 represents the maximum; still, while this is so, the intensity of both these lines in the spectra of the hottest stars is not surpassed, even by those of hydrogen. Hence, opinion as to their representing the same gas must be suspended. Further, I have photographed a line at 4388 apparently coincident with another important line in the same stars. Whether, coming from one source or two, in these three lines seen along with D_3 in the gas obtained by me from Bröggerite, we have, it would seem, run home the most important lines in the spectra of stars of Group III., in which stars alone we find D_3 reversed. Should these results be confirmed, the importance of the gas or gases they represent at a

[1] By Prof. W. Ramsay, F.R.S. (abstract).
[2] Second note. By J. Norman Lockyer, C.B., F.R.S.
[3] See "Solar Physics," Lockyer, p. 612.

certain stage of the evolution of suns and planets can be gathered from an examination of a photograph of the spectrum of Bellatrix.

Another case is afforded by a line at λ 667. This is associated with D_3 in Bröggerite and Cleveite, but the yellow line has been seen in Monazite *without* λ 667. It is almost certain, then, that these two lines represent two gases. Certainty cannot be arrived at till a larger quantity of gas has been obtained.

Again, the red line at λ 6575, close to C, referred to in my previous communication, is seen both in Gummite and Bröggerite; but in one case (Gummite) it is seen without D_3, and in the other with it, in one case (Bröggerite) without λ 614, and in the other with it. The above conclusions hold here also.

This line λ 614, possibly coincident with a chromospheric line, has been recorded in Gummite and Bröggerite. It has been seen *with* D_3 (in Bröggerite) and *without* it (in Gummite).

I have said enough to indicate that the preliminary reconnaissance suggests that the gas obtained from Bröggerite by my method is one of complex origin.

I now proceed to show that the same conclusion holds good for the gases obtained by Profs. Ramsay and Cleve from Cleveite.

For this purpose, as the final measures of the lines of the gas as obtained from Cleveite by Profs. Ramsay and Cleve have not yet been published, I take those given by Crookes,[1] and Cleve,[2] as observed by Thalén.

These are as follows, omitting the yellow line :—

Crookes.	Thalén.
	6677
568.05	
566·41	
516·12	
	5048
	5016
500·81	
	4922
480·63	
	4713·5

The most definite and striking result so far obtained is that, in the spectra of the minerals giving the yellow line, I have so far examined, I have never once seen the lines recorded by Crookes and Thalén in the blue. This demonstrates that the gas obtained from certain specimens of Cleveite by chemical methods is vastly different from that obtained by my method from certain specimens of Bröggerite; and since, from the point of view of the blue lines, the spectrum of the gas obtained from Cleveite is more complex than that of Bröggerite, the gas itself cannot be more simple.

Even the blue lines themselves, instead of appearing *en bloc*, vary enormously in the sun, the appearances being—

4922 (4921·3) = 30 times
4713 (4712·5) = twice.

These are not the only facts which can be adduced to suggest that the gas from Cleveite is as complex as that from Bröggerite. But while, on the one hand, the simple nature of the gases obtained by Profs. Ramsay and Cleve and by myself must be given up, reasoning on spectroscopic lines; the observations I have already made on several minerals indicate that the gases composing the mixtures are by no means the only ones we may hope to obtain.

This part of the inquiry will be more specially considered in a subsequent communication.

I may remark in conclusion that in this preliminary inquiry no attempt has been made to separate the possibly new gases from the known ones which come over with them; hence, the lines are in some cases very dim, and the application of high dispersion is impossible. The wave-lengths, therefore, especially in the visible spectrum, are approximations only; but the view that we are really dealing with gases operative in the solar atmosphere, like the helium which produces D_3, is strengthened by the fact that of the 60 lines so far recorded as new in the various minerals examined, about half occur near the wave-lengths assigned to chromospheric lines in Young's table. I am aware that most of the chromospheric lines have been recently referred to as due to iron, but I believe this result does not depend upon direct comparisons, and it is entirely opposed to the conclusions to be drawn from the work of the Italian observers, as well as from my own.

[1] Nature, vol. li. p. 544.
[2] *Comptes rendus*, April 16, p. 835.

On the New Gas obtained from Uraninite.[1]

In my preliminary note communicated to the Royal Society on the 25th ult. I gave the wave-lengths of the lines which had been observed both at reduced and at atmospheric pressure in the gas (or gases) produced by the method to which I then referred of heating the mineral Uraninite (Bröggerite) in vacuo.

As a short title, in future I shall term this the distillation method.

Since then the various photographs obtained have been reduced and the wave-lengths of the lines in the structure spectra of hydrogen observed beyond the region mapped by Hasselberg.

I have further observed the spectra of other minerals besides Uraninite for the purpose of determining whether any of them gave lines indicating the presence of the gas in Uraninite or of other gases.

I now give a table of the lines so far measured in the spectra of 18 minerals between λλ 3889 and 4580 R, the region in which, with the plates employed, the photographic action is most intense.

Lines Photographed in the Spectra of Gases obtained from various Minerals experimented upon up to May 6.

Wave-length.		Chromo-spheric lines (Ångström's scale.)	Eclipse lines (1893), Rowland's scale (1893).	Orion star lines (Rowland's scale).	Remarks.
Rowland.	Ångström.				
3889	3888·5	3888·73 H.	3889·1	*	U
3947	3946·5	3945·2 H.	3946·0		U
3982	3981·5		3982·0		
4026·5	4025·9		4026·5	4026·5	U
4142	4141·3				
4145	4144·3		4144·0	4144·0	
4177	4176·3	4178·8	4177·8	4178·0	
4182	4181·3				
4338	4337·3	4338	*	4338·0	
4347	4346·3			4346·0	
4390	4389·3	4388·5	4390	4389·0	
4398	4397·3	4398·5	4398·7		
4453	4452·3		4454		
4471	4470·3	4471·2	4471·8	4471·8	U
4515	4514·3	4514·0	4514·5		
4522	4521·3	4522·0	4522·9		
4580	4579·3				

* Broad hydrogen lines extend over these positions.
U = lines noted frequently in the spectra of Bröggerite.
H = photographed by Hale.

On this table I may remark that, of the lines given in my paper of April 25, the final discussion has shown that the following lines are hydrogen structure lines in the region beyond that mapped by Hasselberg :—

λλ 4479, 4196, 4156, and 4152·5.

The line 4368 is also omitted from this list, as it has not been finally determined whether it coincides with a line of O.

In the table, besides the λλ on Ångström's and Rowland's scale, I give lines which have been observed in the sun's chromosphere and chronicled by Young; those photographed during the eclipse of 1893 with a 6-inch prismatic camera, by Mr. Fowler, and those photographed with the same instrument at Kensington in some stars of Group III. of my classification in the constellation of Orion.

This table carries the matter of the relation of the new gases to star and stellar phenomena much further than I ventured to suggest in my second note.

We appear to be in presence of the *vera causa*, not of two or three, but of many of the lines which, so far, have been classed as "unknown" by students both of solar and stellar chemistry; and if this be confirmed, we are evidently in the presence of a new order of gases of the highest importance to celestial chemistry, though perhaps they may be of small practical value to chemists, because their compounds and associated elements are, for the most part, hidden deep in the earth's interior.

The facts that all the old terrestrial gases, with the exception

[1] Third Note. By J. Norman Lockyer, C.B., F.R.S.

of hydrogen, are spectroscopically invisible in the sun and stars—though they doubtless exist there—and that these new gases scarcely yet glimpsed, have already, in all probability, supplied us with many points of contact between our own planet and the hottest part of our central luminary that we can get at, and stars like Bellatrix, are full of hope for the future, not only in relation to the possibility of more closely correlating celestial and terrestrial phenomena, but in indicating that a terrestrial chemistry founded on low density surface products in which non-solar gases largely enter, is capable of almost infinite expansion when the actions and reactions of the new order of gases, almost, it may be said, of paramount importance in certain stages of stellar evolution, shall have been completely studied.

With regard to the differences indicated between the results of the chromospheric and eclipse observations in the above table, it may be useful to remark that Prof. Young's "frequencies," invaluable though they are, must necessarily be of less importance, from the present point of view, than the eclipse observations obtained, it may almost be said, at the same instant of time. There may be, and doubtless are, two perfectly distinct causes for the appearance of the so-called chromospheric lines. First, the tranquil condition of the lower strata of the sun's atmosphere which gives us the pure spectrum produced at a constant—and the highest that we know of in the sun—temperature. Secondly, the disturbed condition which fills the spectrum with lines of a so-called prominence. Formerly it was universally imagined that the prominences were shot up from below; and in that case the lines added would indicate a temperature *higher* than the normal. But I have sent many papers in to the Society indicating the many arguments against this view,[1] and to me, at the present time, this view is almost unthinkable. If these disturbance-lines are produced from above, they may represent the effects of many stages of *lower* temperature. Hence a list of chromospheric lines loses most of its value unless the conditions of each observation are stated, and the phenomena appearing at the same place at the same instant of time are recorded.

Now, this same place and same time condition is perfectly met by eclipse photographs, and hence I attac i a great value to them. But the comparison between such eclipse observations and the spectra of certain stars indicates that the latter in all probability afford the best criteria of all.

1 They are set out at length in the "Chemistry of the Sun," which I published in 1887.

THE MARQUIS OF SAPORTA.

IN the study of palæobotany we may concern ourselves with the various problems of distribution, the geologic sequence of plant types, the value of fossil plants in comparative stratigraphy, and as tests of climatic conditions; or our attention may be concentrated on the important facts revealed by a microscopic study of petrified plant tissues. The latter field of research, in which Prof. Williamson has laboured with remarkable success during the last twenty-five years, is gradually being recognised by botanists as a branch of their science which they cannot afford to neglect in dealing with the wider problems of plant life. Fascinated by the almost incredible perfection in which Palæozoic, and more rarely Mesozoic, species have been preserved, the student of vegetable morphology is apt to take too little heed of the wealth of material which can only be studied in the form of structureless casts or impressions. In the majority of fossil floras the geologist or botanist must perforce confine himself to an examination of the few isolated and imperfect fragments that have escaped destruction in the process of denudation and rock-building, and have been preserved by fossilisation as meagre representatives of a past vegetation. As a specialist in this latter branch of palæobotany, there has been no more ardent worker since the days of Adolphe Brongniart, whom we may regard as the founder of palæobotanical science, than the Marquis of Saporta. Saporta's recent death, at his home in Aix-en-Provence, at the age of seventy-two, has deprived botanical and geological science of anunusually able and vigorous worker.

A perusal of Saporta's numerous contributions to scientific literature affords abundant evidence of critical and detailed investigation during a long period of years; nearly the whole of his published work has been in the domain of fossil botany. The Tertiary vegetation of France forms the subject of several of his contributions to science. From an early stage of his career the Cainozoic plant-bearing strata of Provence have occupied a prominent position in his palæobotanical studies; the Eocene flora of Aix, a valuable monograph on the remnants of an Eocene flora preserved in the tuffs of Sézanne, and various other writings on Tertiary plants, bear eloquent testimony not only to a remarkable power of detailed systematic work, but to a striking aptitude for a broad and philosophic manner of treatment. Students of Mesozoic botany soon learn to appreciate Saporta's memoirs on Cretaceous and Jurassic plants, and especially the splendid series of monographs on the Jurassic flora of France, published as separate volumes of the "Paléontologie Française" from 1873–91; in this profusely illustrated work, dealing primarily with French vegetation, we have to a large extent a general handbook of Oolitic botany. One feature which sets a high value on Saporta's palæobotanical work, is his wide and thorough acquaintance with the facts of distribution and taxonomy of living plants. Palæontological records are often in themselves of no special interest to zoologists and botanists, but if interpreted as indices of plant distribution in past ages, and applied to the wider problems of the evolution and dissemination of plant types, they assume considerable importance. Saporta's knowledge of recent floras, and his keen enthusiasm as an evolutionist, led him to regard fossil plants not simply as convenient aids to the stratigraphical geologist, but as affording indispensable data to the student of plant phylogeny. In "Le Monde des plantes avant l'apparition de l'homme" (Paris, 1879), we have a series of articles originally published in the *Revue des Deux Mondes* and *La Nature*, in which Saporta's encyclopædic information and finished literary style combine to render attractive to the layman and the specialist a retrospect of plant life during the geologic ages. Unfortunately the elaborate frontispiece to this volume, described as the "oldest known land plant," and named *Eopteris Morierei*, is merely a representation of an iron pyrites infiltration on the surface of a Silurian slate, and cannot be retained as a plant impression. In a more recent and smaller volume, "Origine paléontologique des arbres cultivés ou utilisés par l'homme" (Paris, 1888), we have an interesting sketch of the geological history of existing forest trees; and in another and more ambitious work,[1] in collaboration with Prof. Marion, an attempt is made to follow the lines of descent of the several subdivisions of the vegetable kingdom. The palæobotanist who is bold enough to venture on the task of tracing out the ancestry of plant forms, and of attacking the problems of development, is exposed to the very serious danger of allowing unsound links to form part of his chains of life. Saporta's constant desire to treat fossil plants from the point of view of a sanguine evolutionist, who wishes to press into his service all possible pieces of evidence towards the better understanding of the process of plant evolution, has in certain instances been led beyond the limits of accurate scientific reasoning. The majority of the so-called fossil algæ, to which he has devoted considerable attention, have been put out of court by Nathorst and others, as having no claim to consideration as records of thallophytic life; and it is generally agreed that the value of his work in this direction is seriously discounted, by the more than doubtful specimens which are described as vestiges of the lower and more primitive forms of plants. A few months before his death, Saporta completed an exhaustive monograph on

1 Saporta and Marion: "L'évolution du règne végétal" 3 vols 1881-1885.