AN INTRA-MERCURIAL PLANET (?).—A second letter from Prof. Rudolph Wolf, of Zurich, giving further particulars relating to M. Weber's observations at Peckeloh, near Münster, on April 4, 1876, was communicated by M. Leverrier to the Paris Academy on the 11th inst. The sky had been cloudless up to noon, and neither spot nor *facula* was remarked, though the sun's disk was examined three or four times, according to M. Weber's custom. After noon the sky clouded until between 4^h and 5^h, when it cleared in places, and the sun was visible from twenty to twenty-five minutes. Utilising this interval, "M. Weber ne vit pas de facule, quoiqu'il eût promené la lunette sur toute la circonférence du soleil. Tout à coup un petit disque bien arrondi de 12 secondes d'arc se montra. Il se trouvait à 11 secondes de temps du bord oriental, et à la même distance au nord de l'equateur céleste (*sic*). L'astronome eut le temps d'examiner de très-près le voisinage de la tache, et nulle part il n'aperçut le plus imperceptible mouvement de facule, nulle part un nuage avoisinant. Seul le petit disque foncé se détachait sur le fond solaire."

The sky soon after clouded, and it was only at five o'clock on the following morning that it was possible to ascertain that "the phenomenon had disappeared from the surface of the sun." The Peckeloh observation was made at 4h. 25m. P.M., mean time at Berlin. It will be remarked that the observation leaves something to be desired as regards clearness.

The 1st, 2nd, and 3rd of next month are dates when it is desirable the sun's disk should be closely examined for any abnormal spot.

THE BRITISH ASSOCIATION

AMONG the later discussions of the meeting no doubt that which has excited most general notice was the debate on Prof. Barrett's paper "On Certain Abnormal Conditions of Mind." There can be little question that in one sense it dealt with subjects suitable for the department of Anthropology, and the scientific repute of Mr. Crookes, Mr. Wallace, Lord Rayleigh, and Prof. Barrett, necessitates the careful examination of anything they may bring forward. But it is doubtful whether the interests of science are best served by the introduction of subjects which are sure to provoke heated and unscientific discussion at a mixed meeting like that of the Association. Dr. McCann did not obtain very much favour for his ill-judged and extravagant scheme of endowed research which he propounded. A good suggestion was thrown out by one of the foreign visitors at the Lord Provost's spendid banquet to the principal members of the Association, in favour of close union and inter-communication between the British and similar Associations in other countries.

The General Committee passed the following resolution relative to the proposed museum of scientific instruments :—"That the Council be requested to take steps to urge upon her Majesty's Government the advisability of forming a museum of scientific instruments and chemical products, as suggested in the memorial of June last to the Lord President of the Council." The Committee also approved a recommendation that in future the presidents-elect of the various sections be invited to confer with the general secretaries, preparatory to the issue of the first number of the daily *Journal* at each meeting, to arrange the order in which the sectional addresses shall be delivered. Thus members may have an opportunity of hearing more than one sectional address.

The following is a list of the grants made at this meeting for scientific purposes ; the name prefixed is in each case that of the person entitled to call upon the treasurer for the amount :—

	£
Mathematics and Physics.	
*a*Everett, Prof.—Underground Temperature	50
*a*Stokes, Prof.—Reflective Powers of Silver and other Substances (renewed)	20
Thomson, Sir William.—Measurement of the Lunar Disturbance of Gravity	50
*a*Tait, Prof.—Thermoelectricity (renewed)	50
*a*Cayley, Prof.—Publication of Tables of Elliptic Functions	250
*a*Joule, Dr.—Determination of the Mechanical Equivalent of Heat	100
*a*Glaisher, Mr. J.—Luminous Meteors	30
Forbes, Prof. G.—Observation of Atmospheric Electricity in India	15
Chemistry.	
*a*Allen, Mr.—Estimation of Potash and Phosphoric Acid	20
Wallace, Dr. W.—Light from Coal Gas	20
*a*Clowes, Dr. F.—Action of Ethyl Bromo-Butyrate on Ethyl Sodaceto-acetate (renewed)	10
*a*Armstrong, Prof.—Isomeric Cresols and the Law of Substitution in the Phenol Series (renewed)	10
Hartley, Mr. W. N.—Double Compounds of Cobalt and Nickel	10
Brown, Prof. Crum.—Quantitative Estimation of Atmospheric Ozone	15
Hartley, W. N.—Liquid Carbonic Acid in Minerals	20
Geology.	
*a*Evans, Mr. J.—Kent's Cavern Exploration	100
*a*Lubbock, Sir J., Bart.—Exploration of Victoria Cave, Settle	100
*a*Evans, Mr. J.—Record of the Progress of Geology	100
*a*Hull, Prof.—Underground Waters in the New Red Sandstone and Permian	10
*a*Herschel, Prof.—Thermal Conductivities of Rocks	10
*a*Bryce, Dr.—Earthquakes in Scotland	10
Topley, Mr.—Sub-Wealden Exploration	100
Biology.	
Gamgee, Prof.—Physiological Action of Ortho-, Pyro-, and Metaphosphoric Acids	15
Hooker, Dr.—Report on the Family of the Diptero-Carpeæ	20
*a*Stainton, Mr.—Record of Zoological Literature	100
*a*Huxley, Prof.—Table at the Zoological Station at Naples	75
*a*Lane Fox, Col.—Exploration of Ancient Earthworks (renewed)	25
Lane Fox, Col.—Instructions for the Use of Travellers	25
Statistics and Economic Science.	
*a*Farr, Dr.—Anthropometric Committee (partly renewed).	100
*a*Hubbard, Right Hon. J. G.—Common Measure of Value in Direct Taxation	10
Mechanics.	
*a*Froude, Mr. W.—Instruments for Measuring the Speed of Ships (partly renewed)	50
Thomson, Sir William—Secular Experiments on the Elasticity of Wires	100
	£1,620

a Reappointed.

At the concluding general meeting Mr. Griffith read the list of grants, and stated that 2,731 tickets had been sold, producing 2,983*l*. In detail, there had been present 211 old life members, 31 new life members, 318 old annual members, 208 new annual members, 1,243 associates, 696 ladies, and 24 foreign members. Sir John Hawkshaw moved a general vote of thanks to the local authorities and officials, especially mentioning Lord Provost Bain, Sir James Watson, Mr. Grahame, Dr. Blackie, and Mr. J. R. Napier. He said that the Lord Provost's kindness and geniality of disposition, his intelligence, and his power of unlimited work, were most remarkable. Capt. Galton, in seconding the motion, said he had never come in contact with a more energetic local committee.

The hospitality displayed at some of the excursions was magnificent, and the foreign visitors had been most cordially received. Prof. Stokes, of Cambridge, proposed thanks to the University of Glasgow for the very great accommodation it had afforded to the Association; the motion was seconded by Dr. Carpenter. Sir William Thomson proposed the vote of thanks to the President. He thought Dr. Andrews's presidency would be beneficial to the Association in many ways. In his address there were many things the serious and permanent consideration of which would prove most beneficial to the progress of science and of higher education in the country. Dr. Allen Thomson, the President-Designate for 1877, seconded the motion. Dr. Andrews, in responding, expressed his gratification at the scientific character of the meeting, which, he thought, would bear comparison with any other. All the sections had been above the average, and in Section A. numerous papers of no ordinary importance were read. He referred especially to a paper by Dr. Ker, of Glasgow, who had followed up one of the most difficult researches of Faraday, and had presented a paper of great originality and extreme value. There had been little that was sensational in their proceedings, but he believed even the public at large would greatly prefer true scientific work to excitement.

This meeting has been notable for the attendance of eight ex-presidents, viz., Prof. Stokes, Dr. Carpenter, Sir William Thomson, Prof. A. W. Williamson, Sir John Hawkshaw, Dr. Hooker, Dr. Lloyd, and the Duke of Argyll.

REPORTS.

Report of the Committee for Testing Experimentally the Exactness of Ohm's Law, drawn up by Prof. Clerk Maxwell.—The statement of Ohm's law is, that for a conductor in a given state the electromotive force is proportional to the current produced.

If we divide the numerical value of the electromotive force by the numerical value of the current, the quotient is defined as the resistance of the conductor, and Ohm's law asserts that the resistance, as thus defined, does not vary with the strength of the current. The difficulty of testing this law arises from the fact that the current generates heats and alters the temperature of the conductor, so that it is extremely difficult to ensure that the conductor is at the same temperature when currents of different strength are passed through it.

Since the resistance of a conductor is the same in whichever direction the current passes through it, the resistance, if it is not constant, must depend upon even powers of the intensity of the current through each element of the conductor. Hence, if we can cause a current to pass in succession through two conductors of different sections, the deviations from Ohm's law will be greater in the conductor of smaller section, and if the resistances of the conductors are equal for small currents they will be no longer equal for large currents.

The first method which occurred to the Committee was to prepare a set of five resistance-coils, of such a kind that their resistance could be very accurately measured. Mr. Hockin, who has had great experience in measuring resistances, suggested 30 ohms as a convenient magnitude of the resistance to be measured. The five coils, and two others to complete the bridge, were therefore constructed, each of 30 ohms, by Messrs. Warden, Muirhead, and Clark, and it was found that a difference of one in four millions in the ratio of the resistance of two such coils could be detected.

According to Ohm's law, the resistance of a system consisting of four equal resistances joined in two series of two, should be equal to that of any one of the coils. The current in the single coil is, however, of double the intensity of the current in any one of the four coils. Hence, if Ohm's law is not true, and if the five coils when compared in pairs with the same current are found to have equal resistances, the resistance of the four coils combined would no longer be equal to that of a single coil.

A system of mercury cups was arranged so that when the system of five coils was placed with its electrodes in the cups, any one of the coils might be compared with the other four combined two and two.

After this comparison had been made, the system of five coils was moved forward a fifth of a revolution, so as to compare the second coil with a combination of the other four, and so on.

The experiments were conducted in the Cavendish Laboratory by Mr. G. Chrystal, B.A., Fellow of Corpus Christi College, who has prepared a report on the experiments and their results.

A very small apparent deviation from Ohm's law was observed, but as this result was not confirmed by the much more searching method of experiment afterwards adopted, it must be regarded as the result of some irregularity in the conducting power of the connections.

The defect of this method of experiment is that it is impossible to pass a current of great intensity through a conductor without heating it so rapidly, that there is no time to make an observation before its resistance has been considerably increased by the rise of temperature.

A second method was therefore adopted in which the resistance was compared by means of strong and weak currents, which were passed alternately through the wires many times in a second. The resistances to be compared were those of a very fine and short wire inclosed in a glass tube, and a long thick wire of nearly the same resistance. When the same current was passed through both wires, its intensity was many times greater in the thin wire than in the thick wire, so that the deviation, if any, from Ohm's law, would be much greater in the thin wire than in the thick one.

Hence if these two wires are combined with two equal large resistances in Wheatstone's bridge, the condition of equilibrium for the galvanometer will be different for weak currents and for strong ones. But since a strong current heats the fine wire much more than the thick wire, the law of Ohm could not be tested by any ordinary observation, first with a weak current and then with a strong one, for before the galvanometer could give an indication, the thin wire would be heated to an unknown extent. In the experiment, therefore, the weak and strong current were made to alternate thirty and sometimes sixty times in a second, so that the temperature of the wire could not sensibly alter during the interval between one current and the next.

If the galvanometer was observed to be in equilibrium, then if Ohm's law is true, this must be because no current passes through the galvanometer, derived either from the strong current or the weak one. But if Ohm's law is not true, the apparent equilibrium of the galvanometer needle must arise from a succession of alternate currents through its coil, these being in one direction when the strong current is flowing, and in the opposite direction when the weak current is flowing. To ascertain whether this is the case we have only to reverse the direction of the weak current. This will cause the derived currents through the galvanometer coil to flow both in the same direction, and the galvanometer will be deflected if Ohm's law is not true.

Mr. Chrystal has drawn up a report of this second experiment, giving an account of the mode in which the various difficulties were surmounted. Currents were employed which were sometimes so powerful as to heat the fine wire to redness, but though the difficulty of obtaining a steady action of the apparatus was much greater with these intense currents, no evidence of a deviation from Ohm's law was obtained, for in every experiment in which the action was steady, the reversal of the weaker current gave no result. The methods of estimating the absolute value of the currents are described in the report.

A third form of experiment, in which an induction coil was employed, is also described, but though this experiment led to some very interesting results, the second experiment gives the most searching test of the accuracy of Ohm's law.

Mr. Chrystal has put his result in the following form:—If a conductor of iron, platinum, or German silver of one square centimetre in section has a resistance of one ohm for infinitely small currents, its resistance when acted on by an electromotive force of one volt (provided its temperature is kept the same) is not altered by so much as the millionth of a millionth part.

It is seldom, if ever, that so searching a test has been applied to a law which was originally established by experiment, and which must still be considered a purely empirical law, as it has not hitherto been deduced from the fundamental principles of dynamics. But the mode in which it has borne this test not only warrants our entire reliance on its accuracy within the limits of ordinary experimental work, but encourages us to believe that the simplicity of an empirical law may sometimes be an argument for its exactness, even when we are not able to show that the law is a consequence of elementary dynamical principles.

Abstract of the Twelfth Report of the Committee for Exploring Kent's Cavern, Devonshire. Read at Glasgow, September 8.—The Eleventh Report, presented by the Committee to the Association, during the meeting at Bristol in 1875, brought up the narrative of the exploration to the end of July of that year. From that date the work has been carried on uninterruptedly in all respects as in previous years; and it is intended in the present report to describe the researches made during the thirteen months ending Aug. 31 of the present year.

The superintendents have had the pleasure, as in former years, of conducting a large number of persons into the cavern, of explaining to them on the spot the mode of working, and describing the facts which have been discovered, as well as of setting forth their bearing on palæontology and anthropology. The cavern has also been visited by numerous persons, who have been conducted by the "Guide," *i.e.* the foreman of the work, under arrangements laid down by the superintendents.

The Great Oven.—Your Committee stated last year, that on July 27, 1875, they began the exploration of the small passage known as "The Great Oven," which connects with one another "The Cave of Inscriptions" and "The Bear's Den"—the two remotest chambers of the cavern. The Great Oven may be said to consist of three reaches—the eastern, central, and western. The western reach—the only one which has been explored—extends tortuously from its commencement in the south-west corner of the Cave of Inscriptions, for a distance of 58 feet, where it is succeeded by the central reach. At its mouth it is 8 feet high, from the limestone roof to the bottom of the usual 4-feet excavations made by the Committee. Its width is commonly about 4 feet, but at one point it contracts to 3 feet, and at another expands to 7 feet. Throughout its entire length the roof and walls have the aspect of a well-worn water-course.

There was no continuous floor of stalagmite, though here and there portions of such a floor, perhaps never continuous, adhered to and projected from the walls; and pieces of stalagmite, as well as detached "paps" of the same material occurred in the deposit below. There was no reason to suppose that earlier explorers had ever worked in this branch of the cavern.

The deposits were a thin layer of "cave-earth," lying immediately on "breccia," without any intermediate crystalline stalagmite such as occurs in typical sections. At the entrance, and up to 34 feet from it, the usual 4-feet sections failed to reach the bottom of the breccia, so that its depth is undetermined; but at the point just mentioned, the limestone floor was found at a depth of 3·5 feet below the upper surface of the cave-earth, and thence to the inner end of the reach the floor was found everywhere at a depth of from 2 to 4 feet, thus displaying a continuous limestone floor for a length of 24 feet, and giving a pretty uniform height of 8·5 feet to this portion of the reach. The upper surface of the cave-earth ascended from the mouth to the inner end of the reach, at a mean gradient of about 1 in 7, whilst the limestone floor was inclined in the same direction at a somewhat higher gradient.

The total number of "finds" in this part of the Great Oven was 50. The remains yielded by the cave-earth included 2 teeth of hyæna, 6 of bear, 10 of ox, 1 plate of a small molar of mammoth, several bones and pieces of bone, including an astragalous of horse, a few coprolites of hyæna, a portion of a flint flake, and a flint chip.

The flake (No. 6672) is of a pretty uniform cream colour, almost a parallelogram in outline, 1·4 inch long, ·7 inch broad, abruptly truncated at each end—one of which retains the original surface of the nodule from which it was struck—and 3 inches in greatest thickness. The inner surface is slightly concave, whilst the outer is very convex, and consists of three planes or facets, the central one commencing near the but end, whilst those on each side of it extend the entire length of the flake. Its ridges, and, excepting a very few small notches, its lateral edges are quite sharp, and show that it can have had little or no wear and tear in any way, and that in all probability it reached the spot in which it was found, not by the transporting action of water, but by human agency. It was met with less than a foot below the surface of the cave-earth, 40 feet from the mouth of the Great Oven, on Oct. 13, 1875.

The specimens yielded by the breccia were ten teeth of bear and a few bones, none of which call for special description.

The exploration of the western reach of the Great Oven was completed on October 27, 1875, three months having been spent on it.

The Labyrinth.—The existence of the chamber termed "The Labyrinth" was probably known to but few persons when Mr. MacEnery commenced his researches in the cavern in 1825, as what appeared to be its *two* entrances must have then been so nearly filled as to reduce them to the size of mere pigeon-holes. These entrances are respectively about 190 and 200 feet from the mouth of what is called "The Long Arcade," from which the nearest external entrance of the cavern is about ninety feet farther. The name of *Labyrinth* was given to the branch of the cavern now under notice on account of the difficulty which, without a guide, visitors experienced in threading their way between the numerous masses of fallen limestone and the large bosses of stalagmite which occupied its floor. "There was," says Mr. MacEnery, "a tradition of the loss of life here by a young man who ventured to explore it without a guide. It is certain that two gentlemen, who lost their light and way, spent a night of horror here. Dreading to advance for fear of falling into the pits, they remained immovable until their friends came to their relief."[1]

The Labyrinth extends from the Long Arcade, in a south-easterly direction, for about forty-six feet, throwing off three narrow branches at and near its inner end. Of these the central one, opening out of the south-eastern corner, and which it is proposed to call "Matthews's Passage," after one of the workmen, leads into The Bear's Den.

The walls and roof of the Labyrinth, though by no means without traces of the erosive action of flowing water, are in most places extremely rugged, and suggest, by their fretted aspect, that even the last of the numerous blocks of limestone encumbering the floor must have fallen a long time ago.

It is separated from the Long Arcade by a massive curtain of limestone depending from the roof to the depth of nine feet, across a space about eighteen feet wide, being, so to speak, slightly looped up at each end to form two small entrances.

Mr. MacEnery had conducted some diggings in the Labyrinth, and had carried them to a depth of at least three feet at one of the entrances, so that, by assuming a stooping posture, ingress and egress became possible. In all other parts of the chamber his work was much less deep.

Omitting the large blocks of limestone, the deposits were:—

First, or uppermost, a floor of granular stalagmite, from which arose several large bosses also of stalagmite, one of which was eleven feet high above the floor, whilst its base occupied a circular space fully fifteen feet in mean diameter.

Second, a layer of cave-earth, rarely amounting to more than a foot in depth, and sometimes to not more than a few inches, whilst it occasionally reached as much as two feet.

Third, though it may be doubted whether there was a floor of the more ancient, the crystalline, stalagmite in the Labyrinth, the lower, and by far the greater part of the bosses mentioned above was of that variety, and was covered with a comparatively thin envelope of the granular kind, without any mechanical deposit between them.

Fourth, the breccia, or, so far as is known, the most ancient deposit in the cavern, lay immediately beneath the cave-earth, from which there was nothing to separate it, and extended to a depth exceeding that to which the excavations were carried.

In order to achieve the thorough exploration of the Labyrinth, it was necessary to break up all the bosses of stalagmite, with the exception of the largest of them, of which a portion has been left intact, it being believed that it shows strikingly the utter inadequacy of the data derived from a *boss* to solve the problem of the amount of time represented by a *floor*, and *vice versâ*.

The upper surface of the cave-earth rose from the mouth of the Labyrinth to its innermost extremity at a mean gradient of about 1 in 17.

The total number of "finds" in this branch of the cavern was 135, and the specimens they included were as follow:—

Lying on the Surface.—Three portions of ribs and two other bones, the two latter having been cut with a sharp tool, perhaps by an existing butcher, and one bone of bat.

In the Granular Stalagmite.—1 tooth of lion.

In the Cave-earth.—32 teeth of hyæna, 7 of bear, 6 of fox, 3 of horse, 2 of rhinoceros, 3 plates of a molar of a young mammoth, 1 of lion, 1 of ox, and 1 of sheep (of doubtful position); several bones and portions of bone, including a tarsus of bird, and two pieces of bone apparently charred; 1 coprolite, and 1 small chip of flint.

In the Crystalline Stalagmite.—6 teeth of bear, of which 5 were in one and the same jaw.

In the Breccia.—215 teeth of bear, and a considerable number of bones, of which many are good specimens.

The exploration of the Labyrinth was commenced on October

[1] See "*Trans.* Devon. Assoc.," vol. iii., p. 238.

28, 1875, and completed on July 10, 1876, upwards of eight months having been spent on it.

Matthews's Passage.—Having finished their researches in the Labyrinth, the Committee proceeded at once to explore the small branch leading from it to the Bear's Den, and termed, as already stated, Matthews's Passage, thus leaving the two other and adjacent small ramifications to be undertaken on some future occasion. To this course they were tempted mainly by the wealth of osseous remains which, from Mr. MacEnery's description, they are likely to find in the Bear's Den.

Matthews's Passage consists of two reaches. The first extends for about 14 feet towards the south-east, where the second turns sharply towards east-north-east, and, after a somewhat tortuous course of about 15 feet, enters the Bear's Den. Their height is from 9 to 10 feet almost everywhere, measuring, as usual, from the bottom of the excavation, which nowhere reaches the limestone floor; and they vary from 3·5 to 7 feet in width. The walls and roof, the latter especially, bear evident traces of the erosive action of a flowing stream, succeeded by the corrosion due, no doubt, to acidulated water, as the surfaces are much fretted.

There were but scanty traces of a stalagmitic floor in the first reach, in which, however, the earlier explorers had here and there broken ground; but throughout the entire length of the second reach a floor extended from wall to wall, varying from 10 to 24 inches in thickness.

The mechanical deposits in the first reach were the usual thin layer of cave-earth above, and the breccia of unknown depth below; but in the second reach the space beneath the stalagmitic floor was mainly occupied with large loose masses of limestone, some of which required to be blasted more than once in order to remove them. The spaces between them were filled with cave-earth or breccia, with comparatively few specimens of any kind.

The upper surface of the cave-earth was almost perfectly horizontal in the first reach; but in the second it rose towards the Bear's Den at a gradient of about 1 in 7.

Matthews's Passage yielded a total of 49 "finds," including specimens which may be thus distributed:—

In the Cave-earth.—26 teeth of hyæna, 2 of bear, 1 of an immature mammoth, 1 of fox, and a considerable number of bones, many of them being broken, and a few of them gnawed.

In the Breccia.—100 teeth of bear, and a large number of bones. The richest "finds" were met with in a small recess at the junction of the two reaches, where the teeth and bones were huddled confusedly together, suggesting that a rush of water had probably carried them to the spot they occupied.

No trace of man was detected in any part of the Passage, the exploration of which was completed on August 31, 1876, having occupied about seven weeks.

In looking over the work accomplished since the Eleventh Report was presented in 1875, the following noteworthy facts present themselves:—

1. In their Eleventh Report, the Committee sketched the distribution, in the cavern, of the remains of the mammals which characterise the cave-earth. Of this sketch, the following is a brief summary:—The hyæna had been met with wherever the cave-earth was found; the hare had not been detected anywhere in the western division of the cavern—that most remote from the external entrances; the badger, wolf, and ox had not been found beyond "The Charcoal Cave;" and relics of horse, rhinoceros, deer, fox, elephant, and lion had not appeared beyond "The Long Arcade."

It is now necessary to say that remains of ox, horse, rhinoceros, fox, elephant, and lion have all been found *beyond* the Long Arcade, in one or more of the three branches of the cavern explored since the Bristol meeting. In all other particulars the distribution remains at present as sketched in 1875.

2. No tooth, or, so far as is at present known, other trace of *Machairodus latideus* has been met with since the last Report was drawn. In short, the only evidence of the presence of this mammal which the Committee have detected during the continuous labour of almost twelve years, is the solitary incisor found July 29, 1872, a fact well calculated to impress one with the unsatisfactory nature of merely negative evidence. It cannot be doubted that had this comparatively small specimen been overlooked, those palæontologists who were sceptical respecting the occurrence of Machairodus in Kent's Hole, would have believed their scepticism to be strongly confirmed by the labours of the Committee, whilst the number of sceptics would have been greatly increased.

3. As already stated, the Committee spent upwards of ten consecutive months, in 1875–76, in exploring the Labyrinth and Matthews's Passage; yet, during all this time, and in these two important branches of the cavern, they found no trace whatever of prehistoric man. Had they, on receiving their appointment from the British Association in 1864, commenced their researches in either of the branches just named—and such a course was by no means without its advocates—instead of beginning at the external mouth of the cavern, and proceeding thence steadily through the successive chambers and galleries, there can be little or no doubt that Kent's Hole would have been pronounced utterly destitute of any evidence on the question of human antiquity, and but poorly furnished with remains of extinct mammalia. The work would probably have been closed without going further, to the great loss of anthropology and palæontology, as well as of popular education in these important branches of science.

Seventh Report on Earthquakes in Scotland, by Dr. James Bryce, F.G.S.—The past year was a period of comparative quiescence in Scotland. Dr. Bryce described the arrangements made for recording future shocks in the Comrie district. The Committee recommended the erection of seismometers at Ardoch, Dunblane, and Bridge of Allan, where very distinct disturbances were felt in 1873.

Second Report of the Committee on Underground Waters of the New Red and Permian Formations of England, by C. E. de Rance, F.G.S.—The Committee's inquiries have been continued last year, particularly with reference to Liverpool, Birkenhead, Nottingham, and Birmingham. Information has also been promised from Staffordshire. The Committee hope to complete their labours before next meeting of the Association.

Statistics were given by Mr. de Rance regarding the amount of water obtained from wells at Liverpool, Coventry, Birmingham, Leamington, Nottingham, Birkenhead, Warrington, and Stockport. It was mentioned that at Liverpool the level of the water in the public wells is gradually being lowered.

At Barrow-in-Furness a bore for coal 3,210 feet deep, struck, at the depth of 250 feet, a spring which now yields 13,500 gallons daily, and rises 12 feet above the surface. In this case, as had been predicted by Mr. Aveline, a member of the Committee, the Permian rocks were found directly overlying the Millstone Grit, and it was thus proved that the Coal Measures lying to the north are not continuous beneath the Permian. Another important circumstance discovered by this bore was the existence of petroleum in the Millstone Grit.

The New Red Sandstone, being porous and ferruginous, has been found to filter the water and oxidise the organic matter contained in it. Water from wells in the New Red, even when not artificially filtered, ranks high among drinking-waters for purity and wholesomeness, containing little saline and hardly any organic matter.

Taking an average rainfall of 30 inches per annum, and granting that only 10 inches percolate into the rock, the supply of water stored up by the Permian and New Red formations was estimated by the Committee to amount to 140,800,000 gallons per square mile. This rate would give, for the 10,000 square miles covered by the formations, 1,408,000,000,000 gallons. Only a very small proportion of this amount is made available for the supply of cities and towns.

Report on Lower Bagshot Leaf and Fruit Beds, by Mr. W. S. Mitchell.

SECTION B.—Chemical Science.

In Section B the amount of work done during the meeting was very considerable, and the quality of the work was fairly good. On Thursday a considerable number of members attended to listen to the president's address, which has been already reported. The papers read on that day were not of any great interest.

Mr. Pattison Muir gave an account of some preliminary investigations upon *Essential Oil of Sage*. Mr. A. R. Newlands read a paper calling attention to various relations which exist among the atomic weights of the Elements. The greater part of the matter contained in this paper has been, at various times, already made public by Mr. Newlands. In a paper by Mr. J. J. Coleman upon *A New Condensing Machine for the Liquefaction of Gases by combined Cold and Pressure*, attention was drawn to certain dynamical questions relating to the best method of obtaining cold from compressed gas so as to utilise the cold produced in expansion. Mr. Coleman's paper could not well be understood without the sketch which accompanied it. A lengthy paper by Mr. W. Ramsay followed, upon *Picoline*. The author described many new salts of picoline, especially those formed by the action of the halogens, which he showed might be classed as—

1. Picoline + 2 atoms of halogen.
2. Picoline + 1 molecule of haloid acid.
3. Picoline + 1 molecule of haloid acid + 2 atoms of halogen.

By the action of chlorine on picoline an oily body may be also produced, from which, by the addition of water, a solid is obtained, which is probably a hypochlorite derivative. Various other salts of picoline were described. The author thought that discussions concerning the constitutional formula of picoline were as yet premature; his investigations, however, appear to show that this base is not a nitrile nor carbamine, and that it does not contain the methyl group. On oxidation it yields Dewar's pyridene dicarbonic acid.

The last paper read was by Mr. J. Stoddard, *On the Zinc Desilverising Process*. It was of purely technical interest.

On Friday the Section had its hands full of sewage, the result, as might have been anticipated, being unsatisfactory. The papers read on the sewage question were:—*Report of Committee; Experimental Researches on the Chemical Treatment of Town Excreta*, by Mr. J. Coleman; and *Sewage Purification and Utilisation*, by Mr. J. Banks. The committee's report was confined to operations conducted at Romford Farm on irrigation. During the time of experiment it appeared that the nitrogen retained by the crops amounted to 30·34 per cent. of that received in the sewage; the yield of rye grass was good. The committee did not ask meanwhile to be reappointed. Mr. Coleman advocated the use of charcoal, large quantities of which might be obtained in the form of the residue removed from the retorts in the distillation of shale oil. Mr Banks recommended filtration through large beds of wood or peat charcoal, placed in wire cages, with subsequent aëration by exposing the sewage in the form of a thin cascade, to the action of the atmosphere. In the discussion it was admitted that the operations at Romford were carried on at a loss; Mr. Allen congratulated the advocates of irrigation on their acknowledgment of this fact, saying that the sooner they got rid of the idea of making this matter pay, the better. Dr. Fergus traced all the woes of humanity to the water system now in vogue in large towns; Mr. Spence believed in precipitation, while Dr. Gilbert manfully upheld irrigation and filtration.

As usual, when dealing with sewage, everyone held by his own opinion, and no two people agreed as to what was to be done.

In Mr. Allen's report of the work of the committee appointed to investigate the accuracy of the various methods adopted for analysing "Commercial Phosphates and Potash Salts," the latter part of the problem was alone dealt with. The committee approved of Tatlock's method somewhat modified; that is, they thought that soda salts are best removed by washing with a strong solution of platinic chloride, followed by washing with alcohol; but they recommended that in the presence of much sulphates, the method should be modified by getting rid of the greater part of such sulphates by means of barium chloride before adding platinic chloride. Mr. Allen, who read the report, personally did not approve of the plan of adding sodium chloride in order to convert the potassium sulphate into chloride, because in the presence of large quantities of soda salts he always found the results come out rather low; washing with platinic chloride appearing under these circumstances to remove, along with the soda salts, a portion of potassium salt likewise.

In a short paper *On the Physiological Action of Pyro- Meta- and Ortho-Phosphoric Acids*, Dr. Gamgee, F.R.S., showed that while the ortho acid is physiologically inert, the pyro acid is very poisonous, and the meta acid is intermediate in its action.

A paper by Mr. F. H. T. Allan, *On a Safe and Rapid Evaporating Pan*, concluded the day's proceedings.

On Monday morning the Section was summoned to hear Prof. Thorpe's *Report on the Specific Volumes of Liquids*, but owing to the absence of the author the paper was taken as read.

The committee appointed for the purpose of collecting and suggesting subjects for chemical researches, after obtaining the opinions of various well-known chemists, did not recommend a continuation of their labours.

A number of papers were then read. Dr. Emerson Reynolds described experiments on the specific heat of beryllium, which went to prove that the atomic weight of that metal is 9·2; the atomic heat deduced from Dr. Reynolds's experiments being, on this assumption, equal to 5·91. Incidentally Dr. Reynolds showed that the modification of Bunsen's calorimeter used by him might be employed in class experiments, and the accuracy of the law of Dulong and Petit in certain instances thereby demonstrated to students.

Mr. Johnstone Stoney, F.R.S., amused and interested the Section by a number of drawings of tetrahedra, octahedra, &c., on to which he dexterously stuck representations of oxygen atoms, chlorine atoms, and so on. His general endeavour seemed to be to convince his auditors that in most basic salts oxygen is divalent, being in direct combination with the acidifying constituent of the molecule, but that when oxygen is not so directly related to this constituent in basic salts, it is tetravalent.

Dr. Macvicar, of Moffat, brought forward some of his peculiar views as to the constitution of matter, in a paper entitled *On the Possible Genesis of the Chemical Elements out of a Homogeneous Cosmic Gas or Common Vapour of Matter*.

Mr. E. H. Biggs described a new form of voltaic battery. The positive pole consists of a perforated carbon plate, which divides the jar into two divisions; the perforations are closed by means of earthenware plugs. The negative pole consists of a zinc plate. Dilute sulphuric acid is poured into the zinc compartment, and a good oxidising agent into the other. The current is intense, and the result a good constant battery.

The president described a few new derivations of anthracene, remarkable for their instability. Mr. J. T. Brown communicated a note *On Anthracene-testing*.

A modification of the sodium sulphide process for the manufacture of soda ash was described by Mr. W. Welden, under the title of *A Means of Suppressing Alkali Waste*. The sodic sulphate and carbonaceous matter are separately heated, and then brought into contact in a furnace lined with carbon. The sulphuretted hydrogen evolved in the conversion of the sodic sulphide into carbonate is conducted into water containing very finely divided oxide of iron or of manganese; the metallic sulphide so produced is subjected to the action of air, whereby sulphur is thrown down; fresh quantities of sulphuretted hydrogen are then passed in, aëration is again carried out, and so on until about 85 per cent. of sulphur to 15 per cent. of metallic oxide is present. This mixture is dried, and used in the manufacture of sulphuric acid.

Dr. C. R. A. Bright gave a description of some new derivatives of cotarnine, and Mr. Kingzett described briefly his later researches on the *Oxidation of Terpenes*: he stated that the liquid obtained by the oxidation of turpentine was possessed of marked antiseptic properties, which were to be traced to the presence of camphoric acid and peroxide of hydrogen in the liquid.

So many papers relating to technical chemistry were brought forward on Tuesday that it was thought better to sub-divide the Section, allotting the more purely scientific subjects to a sub-section. In this sub-section Dr. Letts described experiments which gave some countenance to the idea that a hydrocarbon having the formula $C_{10}H_{17}$ really existed. His experiments, were not, however, of so exact a nature as to carry conviction to the minds of many of the members. Mr. J. Buchanan described a modified hydrometer used on board the *Challenger*, and also an instrument for registering pressure and temperature at considerable depths.

Papers were read by Dr. Gladstone *On the Copper Zinc Couple*, and by Mr. W. N. Hartley *On Liquid Carbonic Acid in Minerals*.

Mr. R. Da Silva described the general action of hydriodic acid on mixed ethers, having the formula $C_nH_{2n+1}OCH_3$, and Dr. Cameron called attention to "Ammonic Selenio-cyanide." Of those papers which dealt with applied chemistry, the most interesting was one by Mr. J. A. R. Newlands, in which he described the *Alum Process in Sugar Refining*. The object of this process is to remove potash salts by the addition of ammonium sulphate in quantity sufficient to form alum, which is precipitated. The residual acid liquors are neutralised by means of lime. The other technical papers were chiefly occupied with sketches of the various chemical industries of Glasgow and the neighbourhood. Mr. F. Ward described a method for preparing the paper used for cheques, which prevents fraudulent alterations being made in the writing of the cheques.

On Wednesday morning the section met for a short time, when Mr. Pattison Muir read two papers *On Bismuth Compounds*, and *On the Action of Dilute Saline Solution upon Lead*.—Prof. Dewar described some experiments by which he has been able to transform chinoline into aniline. Chinoline, or more probably a mixture of the two bases, C_9H_7N, and $C_{10}H_9N$ yields, on oxidation, a new acid having the formula $C_9H_9NO_3$; when treated with potash lime this acid yields aniline and ammonia only. The author of the paper thought that probably two intermediate bodies are formed, the latter of which has the same formula as indol. Prof. Dewar hopes to separate this body. This investigation shows that the bases of the pyridene series are related to the aromatic nucleus of the benzene series.

Dr. Tilden described his investigation on the *Nitrosoderivatives of the Terpenes.* So far as his experiments have gone, he has found but two different nitroso-compounds having the formula $C_{10}H_{15}NO$—one of these melts at 70°, and the other at 129°. Dr. Tilden also described a substance, isomeric with purpurin, $C_{14}H_8O_5$, produced by the action of chromic acid upon either of the aloms. Mr. Dittmar made some remarks on Reboul's paper on pyrotartaric acid; and also described at some length experiments on the analysis of coal-gas. He did not consider that the ultimate analysis of coal-gas gave any reliable information as to its illuminating power. He showed that benzene vapour may exist in coal-gas, but that by passage into an ordinary gas-holder the greater part of that vapour is removed by the water in the gas-holder. A few other papers were read relating to technical chemistry.

Altogether the section may be congratulated on having got through a fair amount of honest work.

SECTION C.—GEOLOGY.

Notices of Terraces, Flats, and Haughs at High Levels in the Carron Valley, near Falkirk, by Dr. D. Milne-Home, F.G.S.—In the region in question the author said there was highest of all, and first in point of date, a terrace of gravel 150 feet above the present sea-level. The form of this platform was due to the arranging action of water, and probably of the sea. Near its edge it is much denuded and cut into by streams, the fragments now remaining having been sometimes pared down by the action of rivers on either side into sinuous round-backed mounds which in form and structure are exactly what are known as Kaims or Eskars.

Below this level and skirting the rivers, especially the Carron and Bonny, near their confluence, are two distinct sets of haughs or alluvial flats, the one set, covered by ordinary floods and standing about ten feet above the present level of the streams, the other and older set standing 35 feet above the sea-level, and formed by the rivers, while the latter ran at a higher level than that of their present channel, a level which the author judged might be about 25 feet, allowing 10 feet for the ordinary height of floods then as now. At this period, the author maintained, the streams had not begun to cut down to their present levels, as they in all probability debouched on a sea which is now represented by the well-known "Twenty-five foot raised beach."

On the Earthquake Districts of Scotland, by Dr. James Bryce, F.G.S.—Dr. Bryce observed that there are two lines along which earthquakes are commonly observed, the one running from Inverness through the North of Ireland, to Galway Bay, and the other passing east and west through Comrie. The phenomena of earthquakes in the latter district are now being systematically observed and recorded, under the direction of a committee appointed by the British Association, seismometers being employed on the two principles of vertical pendulums and delicately poised cylinders. Arrangements have been made to ascertain whether shocks in this region can be traced to any common central point, there being reason to believe them to be connected with a mass of granite in Glen Lednoch, whose position was indicated on a map exhibited by the author.

The existence in the vicinity of Comrie of important lines of fracture in the earth's crust was pointed out, and it was suggested that these might be records of earthquakes in remote geological times. One of these lines of fracture is filled up with a dyke of basaltic rock, traceable from the Melville Monument, near Comrie, to Loch Lubnaig, and belonging to the series of dykes now regarded as of Miocene age. The other line of fracture is much older, and divides (with an enormous displacement) the Lower Old Red formation from the Metamorphic rocks of the highlands.

For the Comrie earthquakes, Dr. Bryce was inclined to accept Mr. Mallet's explanation, viz., the shock produced by the fall of masses of rock from the roof of some subterranean cavity.

As a remarkable manifestation of earthquake activity, Dr. Bryce alluded to a sudden rise of 2½ feet in the level of Loch Earn, described in a former report of the Earthquake Committee. On that occasion no change in the atmospheric pressure was indicated by the barometer. It was several hours before the motion of the lake's surface, produced by the shock, subsided.

On the Parallel Roads of Glen Roy, by Dr. D. Milne-Home, F.G.S.—Dr. Milne-Home exhibited a map showing the parallel roads as laid down by the Ordnance Survey, and the positions of the barriers necessary for the damming-up of the lake at the successive stages marked by the several beaches or "roads." The author rejected the theory of a marine origin for the beaches, and declared himself unable to accept Prof. Tyndall's view that the lakes were barred by glaciers protruding from lateral valleys.

He then went on to show that solid barriers, not of ice, but of detritus, would alone account for the phenomena in question. The cutting through of the barriers would account for the different levels of the roads. The author pointed out that in the positions where the detrital barriers must have stood, the roads stop short abruptly.

It was pointed out on the map that the detrital mounds in Glen Spean make a horse-shoe bend, with the convexity up the valley. They could not therefore have been derived from a glacier coming down Glen Spean, or from the lateral valley of Loch Treig. Mr. Milne-Home ascribed them to the droppings of icebergs floating eastward up the valley.

Mr. J. Macfadzean also read a paper *On the Parallel Roads of Glen Roy*, supporting the marine theory of their origin.

On the Geology of Foula, Shetlands, by G. A. Gibson, M.B., B.Sc.—The author had constructed from his own observations a geological map of the island, which was exhibited on the wall. A fault running north and south divides Foula into two regions of very different aspect. On the eastern or upthrow side of the fault the rock is a foliated gneiss, much folded and faulted, and copiously veined with red granite and to a less extent with grey granite. There is no granite mass *in situ* in the neighbourhood whence these veins may be supposed to have radiated. The gneiss resembles in character and also in its general strike the Laurentian of the north-west of Scotland.

On the western side of the fault the rocks are flags and sandstones identical with the Lower Old Red beds of the Shetland Islands, although in Foula no fossils have been detected in them. They dip at first at a high angle away from the fault, but gradually become flatter westwards, till they are almost horizontal at the sea. Their thickness is estimated by Mr. Gibson at 6,600 feet.

The granite dykes do not traverse the Old Red rocks.

On the Junction of Granite and Old Red Sandstone in Arran, by E. Wünsch, F.G.S.—The author described and illustrated, by diagrams, sections at Eas na Oich and Corrie, exhibiting a passage from Old Red flags and Conglomerates to the granite of the central nucleus of the island. This fact, the author said, would necessitate the alteration at the points in question, of Dr. Bryce's and Prof. Ramsay's maps, which agreed in representing the granitic nucleus as surrounded by a ring of slates, there being no slates at least as far south as Mouldon. He mentioned that everywhere at the point of contact with the Old Red Sandstone the granite was delicately mottled or clouded, as though the black film of the absorbed mass had remained floating and became fixed in the white pasty mass, and this appearance, he held, was in itself sufficient to point to a junction of granite with rock other than slate, for, though innumerable instances might be seen in other parts of the island of junctions of granite with true slate, in not a single instance was the adjoining granite affected in this particular manner.

A suite of rock specimens was exhibited showing the passage of the sedimentary rocks into granite.

On the most recent Researches into the Structure and Affinities of the Plants of the Coal Measures, by Prof. W. C. Williamson, F.R.S.—Prof. Williamson expressed his strong conviction that the flora of the Coal Measures would ultimately become the battle-field on which the question of evolution with reference to the origin of species would be fought out. There would probably never be found another unbroken period of a duration equal to that of the Coal Measures. Further, the roots, seeds, and whole reproductive structure of the Coal-measure plants are all present in an unequalled state of preservation. With reference to Calamites, Prof. Williamson said that what had formerly been regarded as such had turned out to be only casts in sand and mud of the pith of the true plant.

Brongniart believed, forty years ago, that he had established two types of the plant called calamite, one like our modern equisetums, and the other (Calamodendron) allied to the pines. Prof. Williamson, in the first of his memoirs, announced that this was an error, that there was only one generic type representing the modern equisetaceous plants, but gigantic. He had recently obtained a specimen of a calamite with the bark on, exhibiting the following structure:—

A nucleal cellular pith, surrounded by canals running lengthwise down the stem; outside of these canals wedges of true vascular structure; and lastly, a cellular bark.

Brongniart had further separated Lepidodendron from Sigillaria, being under the impression that a layer of exogenous growth characterises Sigillaria and is absent in Lepidodendron. But Prof. Williamson had obtained a series of young and old specimens which clearly showed that the difference is not generic, but is merely one of species, or of the age of individual plants.

Prof. Williamson also explained that the separation of the genera Asterophyllites and Sphenophyllum was uncalled for, the wedge-shaped leaf of Sphenophyllum being merely the result of the coalescence of several of the leaves of Asterophyllites.

On Labyrinthodont Remains from the Upper Carboniferous (Gas Coal) of Bohemia, by Dr. Anton Fritsch.—The gas coals of Bohemia are unusually rich in remains of Labyrinthodonts, fishes, and insects. They lie near the top of the Coal Measures, and are regarded by Dr. Fritsch as passage-beds, the fauna being of Permian and the plants of Carboniferous types.

Dr. Fritsch exhibited a series of plates, as well as his original specimens. In one Labyrinthodont the skeleton is completely ossified. A Ctenodus has the bony part of the skull preserved. A Diplodus has a perfect lower jaw, with teeth.

Among insects, one new species has the seventh pair of feet enlarged as in Pterygotus.

A new species, named by Dr. Fritsch *Ulus constans*, is interesting as showing how little the genus has changed since Palæozoic times.

On the Strata and Fossils between the Borrowdale Series and the Coniston Flags of the North of England, by Prof. Harkness, F.R.S., and Prof. A. H. Nicholson, M.D.—The authors had found an unbroken succession of the strata on this horizon at several places in the North of England, which, as exhibited in Skellgill, they tabulated as follows:—

Base of Coniston flags, with *Monograptus, Retiolites Geinitzii*, &c.
Knock beds, "pale slates," with casts of a small *orthis*.
Graptolitic mudstones with a grey band full of brachiopods, &c.
Coniston limestone and shale—the shale highly fossiliferous.
Traps, the summit of Borrowdale Group, with ash beds containing rust cavities ("Stylend grassing beds").

These deposits must be for the most part Lower Silurian. Below them are the Skiddaw slates, containing well-marked graptolites. The Skiddaw slates are found neither in Scotland nor Ireland.

The Tarranon shales, which are 300 feet thick in South Wales, develop in the North to a thickness of 1,500 feet, and the Geological Survey has mapped them as conformable to the Bala beds.

South of Bala Lake, Lower Llandovery rocks get in between the Tarranon shales and the underlying Bala beds. Still further to the south the Upper Llandovery comes in.

The authors conclude, therefore, that the Tarranon shales of the North represent also the Upper and Lower Llandovery rocks. They consider also that the Lower Llandeilo of the Southern Uplands of Scotland, estimated by the Geological Survey to have a thickne s of 20,000 feet, is represented in the North of England by contemporaneous igneous rocks.

Notes on the Drifts and Boulders of the Upper Part of the Valley of the Wharfe, Yorkshire, by the Rev. E. Sewell, M.A., F.G.S.—In this region there are two boulder clays, the lower blue and hard, with many glaciated stones, and the upper, and more generally diffused, yellow and looser, and with comparatively few glaciated stones. In the blue clay there are many boulders from the north-west, while those of the yellow clay are for the most part of the local Millstone Grit.

In the upper part of the valley the clays are largely concealed by gravel and sand, which attain a thickness of 150 feet. This deposit appears to graduate into, and alternate with, the underlying yellow boulder-clay. It rises here and there into crooked eskar-mounds. It contains pebbles and boulders mostly of the local Millstone Grit, but there are also some of Carboniferous Limestone.

The Valley of the Wharfe must have been filled up with gravelly drift to a certain height, and then (in post-glacial times) must have commenced the excavation of the present valley.

The author thinks that the theory of a marine origin for the gravel best accounts for the phenomena it presents. The boulders may have been dropped from floating ice.

Above the valley, on the hills of Millstone Grit, there occur boulders of limestone which must have come from the north-west, crossing intervening valleys and ridges. The boulders reach the height of 1,200 feet. There are no erratics on the eastern side of the Pennine Hills above 1,250 feet, but on the western slope they occur at greater heights.

On Ridgy Structure in Coal, with Suggestions towards accounting for its Origin, by Prof. James Thomson, F.R.S.E.—The coal in question was exhibited by the author, and was derived from South Wales. It presented the appearance in miniature of a number of sharp, serrated, labyrinthine mountain ridges. Prof. Thomson suggested that the coal-seam might have diminished in weight owing to the escape of fire-damp, and that thereupon the pressure of the overlying strata might have reduced its bulk, a double series of oblique fissures allowing the upper half of the seam to interlock with the lower half. Experiments on the behaviour of cast-iron columns under pressure had demonstrated the possibility of such fissures.

Further Illustration of the Jointed Prismatic Structure in Basalts and other Igneous Rocks, by Prof. James Thomson, F.R.S.E.—Prof. Thomson suggested that the structure in question might have been induced by the accidental presence of foreign substances in the molten rock. The paper was illustrated by specimens of ochreous clay, and of bricks and fire-clay used in melting gold in the Royal Mint.

SECTION D.—Biology.

After the delivery of the President's Address, Dr. Hooker, in proposing a vote of thanks to him, said that the President should not have termed his address an excursion into the bye-paths of biology, but rather a discovery and exposition of the true value of many small facts hitherto considered trivial. Mr. Darwin and Mr. Wallace were the men who were utilising the "waste observations of biology." He entirely agreed with Mr. Wallace as to the great importance of animal life to the colouration of flowers, but perhaps a broader aspect still was to be thought of in that connection—the influence of climate, the chemical rays of the sun, and cloudy weather. Thus brightly-coloured flowers were much more numerous in the eastern than in the western districts of Great Britain. Again, the further islands were from great continents, the less conspicuous colouration was possessed by their flowers, as a rule.

Department of Anthropology.

Several papers were read bearing upon the Highland race and language. Mr. Hector McLean was of opinion that there was not sufficient basis for the view that the primitive continental Celts were divided into two branches, Gaelic and Cymric. It was perhaps more reasonable to consider the ancient Celtic language as possessing several dialects, varying gradually from the Baltic to the Mediterranean and from the Alps to the West of Ireland. Mr. McLean thought there was a tendency to consider the Celtic languages more Aryan than they really were, and he gave a list of words from non-Aryan languages having a close resemblance in form to Celtic words. The Gaelic language now fringed the whole west of the British Isles, with considerable though gradual dialectical differences. South Kintyre was nearer in language to Antrim than to Skye. He believed that Kerry men and Sutherlanders would not require long intercourse in order to be able to understand each other. Mr. McLean also noticed a number of the physical characteristics of the Western Highlanders, from which he inferred that they had been materially influenced as a race by the Norwegian occupation from the eighth to the thirteenth century. He had looked at Danish, Swedish, and Norwegian sailors side by side with Western Highlanders, and had been surprised at the resemblances between the former and the fair individuals of the latter. Local names of Norse origin were found in all the isles and all along the coast line. His general conclusions were that the Highlanders of the present day were derived from a commixture of several races, pre-Celtic, Celtic, and Scandinavian, and it would seem that there must have been three or four pre-Celtic stocks. Another paper by Mr. McLean was *On the Anglicising and Gaelicising of Surnames.*

Dr. Phené read a paper *On Recent Remains of Totemism in Scotland.* He defined Totemism as a form of idolatry; a totem was either a living creature or a representation of one, mostly an animal, very seldom a man. It was considered, from reference to Pictish and other devices, that a dragon was a favourite representative among such people of Britain as had not been brought under Roman sway.

Mr. W. J. Knowles, of Belfast, gave a further account of the prehistoric discoveries made at Port Stewart, near Londonderry. They were found in pits excavated by the wind among the sand-hills. The remains included arrow-heads, scrapers, hammers, flakes, bone implements, and bones of the horse, ox, pig, dog, &c., together with edible shells, all mixed up together, and apparently of the same age. As late as the 20th of July last the author and two companions had found, in less than four hours, three arrow-heads, two beads, thirty or forty scrapers, and several hammer-stones, as well as bones which bore marks of cutting or sawing. One of the most interesting of recent finds was about a dozen very small stone beads, found within a few yards' radius. They were concave on one side and convex on the other. Mr. Knowles had tested the cutting power of the flint implements on a common beef-bone, using a little water, and he found that he cut through into the hollow of the bone in fourteen minutes; he had also bored a hole through a bone with a piece of flint. The marks made by the flints on recent bones were very similar to those found on the ancient bones. Mr. Knowles also read a paper *On the Classification of Arrow-heads,* recommending the use of the following terms:—Stemmed, indented, triangular, leaf-shaped, kite-shaped, and lozenge-shaped. Commander Cameron mentioned that arrow-heads of the same shape as many exhibited by Mr. Knowles were in use in various African tribes. One shape was formed so as to cause the arrow to rotate, and was principally used for shooting game at long distances. The shape of the arrows varied according to the taste of the makers; in one district there were forty or fifty different shapes.

Commander Cameron read part of a paper by Capt. J. S. Hay, relative to a strange malformation among people in the district of Akem, West Africa, the first announcement of which was received with some incredulity. The malformation in question is confined to the male sex, and consists in a protuberance or enlargement of the cheek bones under the eyes, taking the form of horns on each side of the nose. The malformation begins in childhood, but does not appear to be hereditary. It presents no resemblance to a diseased structure, nor is it a raised cicatrix. An endeavour is being made to procure skulls in which the phenomenon appears, for exhibition to scientific men in London.

Miss A. W. Buckland's paper *On Primitive Agriculture,* was very highly commended by Col. Lane Fox. We can only state her general conclusion that cereals were introduced by pre-Aryan races of common descent over a very wide range of the world; and they also introduced the worship of the moon as an agricultural deity. The absence of agricultural implements in prehistoric remains proved their extreme simplicity; probably only a pointed stick was used, a form still persistent. Some of the stone celts may have been used as hoes, and flint flakes might also have been inserted in wooden frames for use as harrows. Furrows and ridges seemed to have been everywhere used.

Department of Anatomy and Physiology.

A valuable series of researches on certain special poisons was presented from the Owens College Laboratory, in papers separate or conjoint, by Prof. Gamgee, F.R.S., Mr. Leopold Larmuth, and Dr. John Priestley. Vanadium and its compounds have been specially investigated, and found to be irritant poisons, rapidly causing death, often preceded by paralysis, convulsions, &c. When much diluted the solutions act injuriously on bacteria, germinating seeds, fungi, &c. The results are the same whether the solution is injected into the skin, the veins, or the alimentary canal of higher animals. Both before and after division of the respiratory nervous centre, vanadium causes in the first instance a stimulation, and in the next a depression of respiration. When the muscles and nerves of a frog poisoned with vanadium were tested by electricity after reflex irritability was entirely destroyed, the work done by the muscles showed no differences from that of non-poisoned muscles. The action of vanadium on the heart of frogs is curious; when vanadium is injected, the inhibitory centres acting on the auricles are not affected, but the vagus nerve loses its power of inhibiting the contraction of the ventricle. This result causes a dilemma which cannot yet be resolved, for it appears that vanadium is not a poison of the muscular fibres. Experiments have also been made on the relative poisonous activities of the ortho-, meta-, and pyro-phosphoric acids and their compounds, and they have been found to vary considerably in their intensity. Further, a relationship in the various phenomena produced has been made out between the different phosphates and vanadates. Investigations relating to chromium, in which rabbits, guinea-pigs, and frogs were employed, demonstrate considerable differences in its physiological action from that of vanadium. At first it induces irritation of the alimentary mucous membrane, and secondly it acts directly on the principal nervous centres, causing convulsions, paralysis, vomiting, a fall of blood pressure, and a sudden and temporary stoppage of the heart in dilatation. It is not specially a poison of muscle or of nerve-trunks.

In the discussion which followed the reading of these papers, Prof. Kronecker, of Leipzig, expressed his opinion that the vanadates were really poisons of the muscular substance of the heart, and he accounted for the differences between the action on the auricle and ventricle by supposing a certain difference between the muscular substance of these two chambers. Dr. McKendrick, who presided in this department, said that Prof. Gamgee's researches showed the advantage of the combination of the highest chemical with physiological knowledge, and they led to the hope that ultimately some definite laws would be discovered regulating the relations between chemical constitution and physiological action. The field of inorganic chemistry was a very fertile one for this purpose, and much more likely to yield great results of this kind than the more complex considerations of organic chemistry. One important result was confirmed by Prof. Gamgee's investigations, that the larger the molecule of a substance the more powerful was its operation, but this was affected also by the stability of the molecule.

Prof. Gamgee also read a paper *On the Changes of Circulation which are observed when Blood is expelled from the Limbs by Esmarch's Method.* The experiments were conducted on healthy students. When the blood was expelled from one leg the heart beat more rapidly, but only for a short time, and the same result followed the application of the bandage to the second leg. When the heart began to beat at its usual rate the tourniquets were loosened, and in an instant the limbs, previously blanched, became suffused with a blush, while sensibility therein became more and more blunted, and the heart bounded off at an exceedingly rapid rate, to return, however, to its normal beat almost immediately. It has been suggested that the increase of the heart's beat when the bandage is applied is intimately connected with the diminution of the normal difference between arterial and venous pressure. It appears likely that an increase of pressure on the right side of the heart tends to quickening the beating of the heart, and the increase of rapidity on removing the bandage round the limb was no doubt the result of the sudden diminution of arterial pressure thus caused. Prof. Kronecker desired that it should not be lost sight of that the altered chemical composition of the blood also had some influence in this matter.

Dr. Stirling, of Edinburgh, gave a very lucid account of his discovery of small nerve ganglia in many parts of the lung, and especially in relation to the bronchi at the base of the lung. These small collections of ganglion cells may be either in the course of the nerves or at their forks. They are directly continued by two extremities into the gray or sympathetic nerve-fibres. Dr. Stirling believed that these were local nerve-centres for the muscular fibres of the blood-vessels, controlling their calibre, and thus regulating the amount of blood passing through them. Dr. Gardner threw out the idea that these local nerve-centres might have another function, that of regulating the capacity of different bronchi, and so varying the amount of air admitted to or expelled from particular regions of the lung. He had long believed that some such arrangement must exist, in consequence of stethoscopic observations both on the healthy and the diseased subject. Dr. Stirling suggested that this regulating power might reside in the higher nervous centres, for stimuli could be sent down through any limited number of fibres of the whole respiratory nerves. Many of the distinguished physiologists present expressed high praise of Dr. Stirling's abilities as shown in this research.

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Mr. J. Gwyn Jeffreys, F.R.S., gave an account of the biological results of the voyage of the *Valorous* to Disco Island in 1875, which will be published in full in the *Proceedings* of the Royal Society. He urged the importance of repeated expeditions of this kind. A century of hard work would not suffice to collect all the information that was needed. Hitherto naturalists had only scraped the bottom of a few acres out of the many millions of square miles of the ocean. The British nation had hitherto done very little for submarine discovery in proportion to the poorer countries of Scandinavia, which had sent out expedition after expedition, yielding the most valuable results to science. Unfortunately, the latest intelligence as to the present Norwegian enterprise was that their work had been much interfered with by tempestuous weather. An important result of Mr. Jeffreys' experience was the bringing up of large and small stones, some very sharp, from the sea-bottom, at great depths. He thought telegraphic engineers had not taken this sufficiently into account in the construction of cables, having proceeded as if they had only to deal with an entirely soft bottom. The number of species of mollusca obtained by the *Valorous* was 183, of which forty were new to science. His opinion, derived from personal knowledge of the American, as well as of the European, fauna, was that the submarine fauna of Davis' Straits was predominantly European, although a number of American forms were found with them. An interesting feature was the discovery of a number of species previously only known in a fossil state in Tertiary rocks far distant, as in the Mediterranean; other species were remarkable because it was now for the first time shown what an enormous range in space and latitude they had, sometimes at least 1,200 miles. Dr. McIntosh, of St. Andrews, Prof. Dickie, of Aberdeen, and Dr. Carpenter gave addresses respectively on the Annelids, the Diatoms, and the Arenaceous Foraminifera brought home by the *Valorous*, and confirmed Mr. Gwyn Jeffreys in maintaining the predominance of European forms.

Mr. John Murray gave an address on oceanic deposits and their origin, based on observations on board the *Challenger*. He described and exhibited specimens of various kinds of deep-sea deposits. He did not think the detritus of the modern land was carried more than two or three hundred miles from the shore. A novel constituent of the deepest sea-bottoms was pumice dust, which had been found in almost every region, arising from submarine volcanic action. Mr. Murray thought he had never failed to find a piece of pumice, when it was carefully looked for in any of the dredgings, and he believed it to be the chief origin of the deep-sea clays. Another element which appeared to have been detected at great depths was "cosmic dust," or dust formed from aërolites. Another interesting point was that whenever they got into deep water, they found manganese peroxide in nodules inclosing organic remains—sharks' teeth and pieces of bone. This formation seemed to be connected with the disintegration of volcanic rocks. Mr. Murray also discussed the question whether true equivalents of the deep-sea deposits now made known were to be found in the series of stratified rocks. If this were not the case, then it must be held that the great continents had remained substantially the same throughout a vast length of time.

FORCE[1]

At short notice it was not to be expected that I could produce a lecture which should commend itself to the Association by its novelty or originality. But in science there are things of greater value than even these—namely definiteness and accuracy. In fact without them there could not be any science except the very peculiar smattering which is usually (but I hope erroneously) called "popular." It is vain to expect that more than the elements of science can ever be made in the true sense of the word popular; but it is the people's *right* to demand of their teachers that the information given them shall be at least definite and accurate, so far as it goes. And as I think that a teacher of science cannot do a greater *wrong* to his audience than to mystify or confuse them about fundamental principles, so I conceive that wherever there appears to to be such confusion it is the *duty* of a scientific man to endeavour by all means in his power to remove it. Recent criticisms of works in which I have had at least a share, have shown me that, even among the particularly well-educated class who write for the higher literary and scientific journals, there is wide-spread ignorance as to some of the most important elementary principles of physics. I have therefore chosen, as the subject of my lecture to-night, a very elementary but much abused and misunderstood term, which meets us at every turn in our study of natural philosophy.

I may at once admit that I have nothing new to tell you, nothing which (had you all been properly taught, whether by books or by lectures) would not have been familiar to all of you. But if one has a right to judge of the general standard of popular scientific knowledge from the statements made in the average newspaper—or even from those made in some of the most pretentious among so-called scientific lectures—there can be but few people in this country who have an accurate knowledge of the proper scientific meaning of the little word Force.

We read constantly of the so-called "Physical Forces"—heat, light, electricity, &c.—of the "Correlation of the Physical Forces," of the "Persistence or Conservation of Force." To an accurate man of science all this is simply error and confusion, and I have full confidence that the inherent vitality of truth will render the attempt to force such confusion upon the non-scientific public quite as futile as the hopelessly ludicrous endeavour of the *Times* to make us spell the word chemistry with a Y instead of an E. It is true that in matters such as this last a good deal depends (as Sam Weller said) "on the taste and fancy of the speller"—and sometimes even absolute error is of little or no consequence. But it is quite another thing when we deal with the fundamental terms of a science. He who has not exactly caught their meaning, is pretty certain to pass from chronic mistakes to frequent blunders, and cannot possibly acquire a definite knowledge of the subject.

In popular language there is no particular objection to multiple meanings for the same word. The context usually shows exactly which of these is intended—and their existence is one of the most fertile sources of really good puns, such as those of Hood, Hook, or Barham. And there is no reason to object to such phrases as the *force of habit*, the *force of example*, the *force of circumstances*, or the *force of public opinion*. But when we read, as I did last week, in one newspaper, that the "force" of a projectile from the 81-ton gun has at last reached the extraordinary amount of 1,450 feet, in another that the "force" of a ball from the great Armstrong gun, lately made for the Italian government, is expected to average somewhere about 30,000 foot-tons—and in a third that the water in the boiler of the *Thunderer* "would in a second of time generate a 'force' sufficient to raise 2,000 tons one foot high"—we see that there must be, somewhere at least, if not everywhere, a most reckless abuse of language. In fact we have come to what ought to be scientific statements, and *there* even the slightest degree of unnecessary vagueness is altogether intolerable.

Perhaps no scientific English word has been so much abused as the word "force." We hear of "Accelerating Force," "Moving Force," "Centrifugal Force," "Living Force," "Projectile Force," "Centripetal Force," and what not. Yet, as William Hopkins, the greatest of Cambridge teachers, used to tell us—"Force is Force"—*i.e.*, there is but one idea denoted by the word, and all force is of one kind, whether it be due to gravity, magnetism, or electricity. This alone serves to give a preliminary hint that (as I shall presently endeavour to make clear to you) there is probably no such *thing* as force at all! That it is, in fact, merely a convenient expression for a certain "rate." If anyone should imagine that "3 per cent." is a sum of money, he will soon be grievously undeceived. "3 per cent." means nothing more nor less than the vulgar fraction $\frac{3}{100}$. True, the "*Three Per Cents*" usually means something very substantial—but there the term is not a scientific one. Think for a moment how utterly any one of you, supposed altogether ignorant of shipping, would be puzzled by such a newspaper heading as "*The White Star-Line*" or "*The Red Jacket-Clipper*." No doubt some of our scientific terms approach as near to slang as do these; but we are doing our best to get rid of them.

A good deal of the confusion about Force is due to Leibnitz and some of his associates and followers, who, whatever they may have been as mathematicians, were certainly grossly ignorant of some elementary parts of dynamics, insomuch that Leibnitz himself is known to have considered the fundamental system of the *Principia* to be erroneous, and to have devised another and different system of his own. This fact is carefully kept back now-a-days, but it *is* a fact, and (as I have just said) has had a great deal to do with the vagueness of the terms for *Force* and *Energy* in some modern languages. In fact, in their modern

[1] Evening lecture by Prof. Tait at the Glasgow meeting of the British Association, Sept. 8.