THE last number of the *Quarterly Journal of the Meteorological Society* contains a letter from M. Hoffmeyer, Director of the recently established Meteorological Institute of Denmark, giving some details of the work it is intended to accomplish. The sphere of the Institute embraces all the branches of Meteorological Science, and it is especially intended to establish in favourable situations a series of stations, furnished with accurate instruments, by which it will be possible, every morning, to send telegraphic communications to the chief station at Copenhagen, and from that, according to agreement, to foreign societies. When the stations are fairly in working order, observations will be published monthly. It is also proposed by the Institute to establish about ten complete meteorological stations at the Faroe Isles, Iceland, and in Greenland; half of these are expected to be in trim by next winter. Besides the general interest attaching to these stations, it is hoped they may tend to foster a system of international meteorology, and pave the way for the laying down of a northern telegraphic cable between Europe and America. The observations at these stations will be specially published. The establishment of this Institute is likely to be of the greatest service to general meteorology.

IN "Railways or No Railways; the Battle of the Gauges Renewed," those who take an interest in the subject will find the case on behalf of the narrow gauge fully and ably set forth.

A "DISSERTATION on the Use of the Stethoscope in Obstetrics," by Æneas Munro, M.D., read before the Royal Medical Society of Edinburgh, seems to be a valuable contribution to the science of the subject to which it relates.

WE have received a pamphlet, "Irrigation not necessary in Upper India," by Major A. F. Corbett, Superintendent Budaon Police, in which the author attempts to prove that irrigation, instead of fertilising that country, will inevitably render it an almost barren waste. The statements he adduces, and the opinions of eminent scientific men and others that he quotes, certainly appear to bear out the writer's theory, and on that account his pamphlet deserves the attention of all who take an interest in the welfare of India.

THE "dead season" has brought up its usual crop of reports of the re-appearance of the sea-serpent, mostly easily resolvable into masses of floating sea-weed. The following extract from an evening contemporary well illustrates the hazy ideas prevalent as to the extinct Saurian monsters of which the sea-serpent is supposed to be a descendant:—"If the sea-serpent continues in its present sociable state of mind, we may perhaps have an opportunity of deciding the vexed question regarding the formation of that portion of his figure which, according to English observers, he keeps concealed under the water. The legend of the Lambton Worm, a popular tale in the North of England, describes the worm as a serpent of enormous size, who used to coil himself round a hill overhanging the River Wear, just as thread is wound round a reel, but a very ancient stone effigy of the creature which lately existed at Lambton Castle, represents it with ears, legs, and a pair of wings. If this effigy was made, as it probably was, *from some recollection* or recent tradition of the Lambton Worm, these adjuncts would indicate that the beast was one of the *winged land monsters* which existed at the same time as the *Ichthyosaurus*, but would naturally become an extinct species far sooner than the *fish lizard*, which can conceal itself in the depths of the ocean from the curiosity and violence of man."

IT is not for want of good examples that the British Government is so backward in encouraging deep-sea dredging; other governments seem to think it their interest or duty to do so. The United States, as we know, have fitted out an expedition under MM. Agassiz and Pourtales, to explore the Gulf Stream, the Straits of Magellan, and the Pacific Ocean. A second American expedition will, in the same way, explore the northern regions of this ocean; the German Empire has undertaken to search the depths of the Atlantic; while Sweden has sent to Baffin's Bay two ships fully equipped for deep-sea sounding.

THE BRITISH ASSOCIATION

SECTION A—MATHEMATICAL AND PHYSICAL SCIENCE

Fifth Report of the Committee for investigating the Rate of Increase of Underground Temperature downwards, and in various localities of dry land and under water, by Prof. Everett.

IN December last, intelligence was received from Prof. Sismonda that the administration of the railway owning the Alpine tunnel had given permission to Father Secchi to carry on a series of observations in the tunnel concerning terrestrial magnetism, and that this distinguished observer was willing at the same time to conduct observations of temperature in accordance with the plans of your Committee. Two maximum and two minimum thermometers were accordingly placed in Father Secchi's hands; but it appears that the arrangements for commencing the magnetic observations are not yet completed, and that accordingly no observations of temperature have as yet been taken.

Prof. Lubimoff of Moscow, on receiving a copy of last year's report, wrote to the secretary, correcting a mistake in the description of the thermometer used in taking observations in the Moscow well. The thermometer was enclosed in a hermetically sealed case containing air, and was therefore completely protected against any possible effect of pressure. Prof. Lubimoff at the same time asked to be furnished with a thermometer of the new pattern described in the report (the upright-Negretti pattern), and one of these instruments was accordingly sent.

Dr. Wild of the Central Observatory, St. Petersburg, wrote in January, requesting that two thermometers for observations in bores might be ordered in his name. At this time, the Secretary was in correspondence with Sir Wm. Thomson, who entertained doubts as to the successful working of the new thermometer, and expressed a preference for the Phillips pattern (which has been described in preceding reports) and the Casella-Miller pattern (a modified Six) which has been extensively used for deep sea temperatures. Thermometers of these two patterns were accordingly ordered and despatched to Dr. Wild.

A letter was received from Prof. Henry of the Smithsonian Institution, Washington, in April, stating that the Chief Engineer of the Hoosac Tunnel had promised to have observations of temperature taken in the tunnel, if thermometers were sent. Its total length will be $4\frac{3}{4}$ miles, about two-thirds of which has been penetrated, by working from both ends and from a central shaft 1,028 feet deep. The mountain has two ridges, under which the tunnel passes, and their heights above it are respectively 1,720 and 1,420 feet. Four thermometers have been sent, viz.: two large minimum Rutherfords, for observations in the tunnel, and two upright Negrettis, for observations in the shaft.

The Council of the School of Mines at Ballaarat, Australia, have, in compliance with a request addressed to one of their number by our observer, Mr. David Burns, C.E., consented to take charge of these thermometers, and furnish observations from the bores and shafts in that important gold-mining district. Most of the principal mining managers are connected with the school. Four thermometers have accordingly been sent, viz.: two upright Negrettis for observations in bores, and two simple mercurial thermometers, of large size, for observations during the sinking of shafts.

Some exceedingly deep Artesian borings have been undertaken in France in recent years; and the President of the Geological Society, Mr. Prestwich (who has allowed his name to be added to your Committee) has furnished your Secretary with introductions which will probably lead to the obtaining of very numerous and valuable observations from these wells.

The largest of them all is one which is now sinking for the municipality of Paris, at La Chapelle, St. Denis, a northern suburb of Paris, and has already obtained a depth considerably exceeding that of the Puits de Grenelle. It is expected that its final depth will be about 2,300 feet. Application was made by the Secretary to the eminent firm of well-borers, Messrs. Mauget, Lippmann, and Co., who are sinking the well, and these gentlemen at once in the most obliging manner consented to take observations of temperature in it. An upright Negretti thermometer was accordingly furnished; and about the 20th of June your Secretary had the pleasure of receiving from them two complete sets of observations taken on the 14th and 15th of that month with their own hands, at every 100th metre of depth, and also at the bottom of the well, 660 metres deep.

Depth in Metres.	FIRST SERIES. June 14, 15. Temp. Fah.	Time down. h.	m.	SECOND SERIES. June 17, 18. Temp. Fah.	Time down. h.	m.
	°			°		
100	58·0	0	35	58·0	3	30
200	61·1	0	30	61·0	2	0
300	65·0	0	30	65·0	2	0
400	69·0	3	10	69·0	11	20
500	72·6	0	30	72·6	2	0
600	75·8	0	30	75·4	2	0
660	83·25	15	45	83·25	2	0

The observations are given in the subjoined table, in which the third column shows the time that the thermometer was allowed to remain at the depth specified before hauling up and reading. The temperature at which the thermometer was set before letting it down is also given in Messrs. Mauget and Lippmann's report, but is not here inserted.

The agreement between the first and second set of observations is remarkably close; and as the time of leaving the thermometer in the water was about half-an-hour in most of the observations of the first set, and two hours or more in all the observations of the second set, it is obvious that half-an-hour is a sufficient time to give a correct observation. This conclusion is satisfactory both as regards the reliability of the observations themselves, and also as establishing the fact that this pattern of thermometer is not unreasonably slow in its working. The exactness of the agreement also serves to show that the thermometer can be depended on to the tenth of a degree, and that we may henceforth use it with confidence.

Before proceeding to discuss the observations, it will be convenient to give a few particulars respecting the well, which have been kindly furnished by Messrs. Mauget and Lippmann.

It was commenced by the municipal authorities as a masonry well, by the ordinary method of digging, until it had reached a depth of 34·5 metres. The intention was to carry it in this way to the depth of about 135 metres, the estimated depth of the tertiary strata covering the chalk; but the difficulties and dangers which were encountered, from the want of tenacity in the soil (*la nature essentiellement ébouleuse des terrains*), and latterly from the insufficiency of the pumps, rendered it necessary to abandon this intention; and in May 1865 the task of completing the well by boring was assigned to Messrs. Degousée and Laurent, the predecessors in business of the gentlemen to whom we are indebted for these observations. A small trial bore (0·2m. in diameter) was commenced, and continued till January 1866, by which time the machinery for the heavier work was ready. In order to support the masonry, which showed signs of giving way, it was tubed through its whole length with a tube 1·8m. in diameter and 0·02m. thick, cemented externally. From the bottom of this tube, at the depth of 34·5m., a bore 1·7m. in diameter was carried to the depth of 68·7m. from the surface of the ground. A second tube 1·58m. in internal diameter was inserted to the depth of 121·6m., and a third tube of internal diameter 1.39m. was carried down into the chalky marls and the upper portion of the chalk at the depth of 139·15m. from the surface. From this point downwards, the bore has been driven through the chalk, and tubing has been unnecessary, its diameter at the depth of 662m. being still 1·35m.

The thickness of the tertiary strata is 137m., and the elevation of the surface of the ground above sea-level is 48m. or 157ft.

The springs which were met with in the tertiary strata correspond to those found in other parts of the basin in which Paris is situated, and have not sufficient strength to spout above the surface of the ground at this elevation. They were encountered at the depths of 19·2m., 34·5m., 86·0m. and 97·0m., and the water now stands in equilibrium in the central tube at 16·5m. below the surface of the ground.

It was not practicable to take observations of temperature during the regular progress of the boring, but an interruption occurred on the 12th of June, and the tool was not at work from this date till after both sets of observations were finished. In reference to this point, Messrs. Mauget and Lippmann, say, under date April 29, "To obtain the natural temperature, it will be necessary to select a time when the work has been interrupted for several days; for the boring being executed by the fall of a heavy tool upon the bottom of the well, the percussion developes a considerable amount of heat, as we perceive by the mud (*les boues*) which we extract, and which in coming to the surface is found to have still a temperature of from 48° to 90° C. (118° to 194° F.)." In their letter of June 19, containing the report of the observations, they remark:—

"You will observe that though the water at the bottom of the well is still some degrees above its natural temperature owing to the action of the drill (*trepan*), the latter has not been in operation since the 12th of the month. At a convenient time, we intend to observe the temperature of the mud as it lies at the bottom of the well, immediately after the withdrawal of the drill, when the latter has been working constantly, a temperature which will probably be found to depend upon the hardness of the rock."

The following table exhibits the successive increments of temperature showed in the second series, which purports to be more accurate.

Depth in Metres.	Increase in deg. Fahr.	Metres per deg. Fah.	Feet per deg. Fah.
	°		
100 to 200	3·00	33·3	109
200 to 300	4·00	25·0	82
300 to 400	4·00	25·0	82
400 to 500	3·60	27·8	91
500 to 600	2·80	35·7	117
600 to 660	7·85	7·6	25

The last two columns of this table show that the rate of increase is about four times as rapid in the last 60m. as in the rest of the well, a circumstance which naturally suggests the explanation given by Messrs. Mauget and Lippmann. There are however some difficulties in the way of accepting this view. Comparing the two sets of observations, one taken on the second and third day after the withdrawal of the tool, and the other on the fifth and sixth day, we have precisely the same temperature at the bottom of the well on both occasions, although the observations were sufficiently precise to detect a difference of a tenth of a degree where such difference existed. It seems difficult to believe that a temperature 2½ degrees above the normal temperature could have remained for two days without sensible diminution. In connection with this question, the apparent cooling to the extent of 0°·4 at the depth of 600m. between the first and second observation demands attention, and is not very easily explained.

If the observed temperature at 660m. is to be taken as the normal temperature, the average increase from 100m. to that depth is at the rate of 1° F. in 22·1m. or in 72·5 ft. If the observed temperature at 600m. in the second series is adopted, the increase from 100m. to that depth is at the rate of 1° F. in 28·7m. or in 94·2 feet.

The observations prepared by Messrs. Mauget and Lippmann in the paragraph above quoted will be eminently calculated to assist in showing the correct interpretation.

Mr. G. A. Lebour, F.G.S. of H.M. Geological Survey, has furnished observations taken in a bore hole executed at the bottom of South Hetton Colliery, Durham. The observations were taken by Mr. J. B. Atkinson, a student at the Newcastle College of Physical Science, and appear to have been carefully made. Thanks are also due to the viewer of the colliery, Mr. Matthews, for granting the requisite facilities.

The hole is 2½ inches in diameter, and was bored out of the pumping side of the South Hetton shaft, in order that the bore rods might be the more readily altered. The depth of the shaft is 1,066 feet; that of the bore hole 863 feet from the bottom of the shaft, or 1,929 feet from the surface of the ground. The section of the boring (not including the shaft) consists of 123 alternating beds of shale and sandstone,* with occasional thin seams of coal and some fire clays. The bottom of the boring has reached a very coarse white grit, which is supposed to be the topmost bed of the millstone grit series.

The bore was dry at the time of its execution; but has since become filled with water, probably derived from the shaft above it. Streams, in fact, pour down the shaft, and play about the hole.

*A complete list of the strata has been furnished, and will be preserved by the Secretary, with a view to future reference if required.

Two thermometers, one of them an unprotected Phillips, and the other a protected Negretti, were supplied by the Secretary to Mr. Lebour, as it was not certainly known at that time whether the bore was dry or wet. Mr. Lebour indeed believed it to be dry, but nevertheless selected the Negretti thermometer, as it was thought that the Phillips could not be read off accurately with the poor light which in the position of this bore hole was alone available.

The following table exhibits the results of all the observations which have been taken in the bore, including three which were taken in 1869, while the boring was going on. The boring was stopped, in the case of each of these three observations, only about 20 minutes before the observations were made; and the heat due to friction appears to have produced abnormal elevation of temperature, amounting to about 2° at the depth of 288 feet, to about 6° at the depth of 582 feet, and to considerably more than this at 858 feet. The other observations in the table are Mr. Atkinson's, taken with the Negretti thermometer.

Depth from bottom of shaft, in feet.	Depth from surface of ground, in feet.	Temperatures observed during boring, April 1869.	Temperatures observed April 1872.
100	1166	—	66
200	1266	—	$68\frac{3}{4}$
288	1354	72	—
300	1366	—	70
400	1466	—	72
500	1566	—	$74\frac{1}{2}$
582	1648	82	—
600	1666	—	$76\frac{1}{8}$
644	1710	—	75
670	1736	—	$77\frac{1}{3}$
858	1924	96	

The temperature 75° at the depth of 644 feet, a temperature lower than either of the two between which it stands, was taken on the first day of Mr. Atkinson's observations, and was confirmed by repeated trials at that time. This was the lowest depth that could then be reached, the remainder of the boring being apparently plugged up with "sludge." A spike was subsequently attached to the thermometer case, which enabled it to pierce deeper into the sludge; but the lowest depth which could be reached (670 feet) is still far from the bottom of the bore.

It is intended to take a fresh series of observations at every 50th foot of depth, and especially to re-examine the temperatures at about 650 feet, where the reversal of temperature was observed.

The following are the rates of increase deduced from Mr. Atkinson's observations, omitting the temperature 75° at the depth of 644 feet.

Depth in feet.	Increase in deg., Fahr.	Feet per deg.
100 to 200	$2\frac{3}{4}$	36
200 to 300	$1\frac{1}{4}$	80
300 to 400	2	50
400 to 500	$2\frac{1}{2}$	40
500 to 600	$1\frac{5}{8}$	62
600 to 670	1	70
		51·2
100 to 670	$11\frac{1}{8}$	

The average increase between the depths of 100 and 600 feet is 1° in 51·2 feet. These depths are reckoned from the top of the bore hole, which is 1,066 feet below the surface of the ground. Mr. Lebour assumes that the temperature at the depth of 600 ft. from the surface of the ground is 48°. Accepting this estimate, we have a difference of $29\frac{1}{8}$° in 1,676 feet, (1,066 + 670 − 60 = 1676) which is at the rate of 1° in 57·5 feet.

Mr. David Burns, F.G.S., reports that, from changes in the management of the mines, and other causes, it has not been possible as yet to carry out the dry observations at Allenheads mentioned in last year's report.

Only one other shaft has been met with at all suitable for observation. It is called Brandon Walls shaft, and belongs to the Rookhope Valley Mining Company, to the courtesy of whose agent we are indebted for liberty to take observations. This shaft is some 6 miles east of those reported on last year, and is situated in the very bottom of Rookhope Valley. The mouth is covered over with a wooden shed, the shaft itself is free from all obstruction, and the water in it has not been disturbed for some ears. The shaft is 333 feet deep, and is full of water to within 25 feet of the surface of the ground. Observations (by Mr. Burns and Mr. Curry of Bolkburn) were taken in it on five different days in July of the present year; but though agreeing well with one another from day to day, they are so irregular that they throw little light on the rate of increase of underground temperature. At the depths of 83 and 133 feet from the ground, the temperature was 48°·5. In the next 50 feet there was an increase of about 3°, the temperature at 183 feet being about 51·4, and from this depth to the bottom (an interval of 150 feet) the temperature was nearly constant. The best determination of the temperature at the bottom was 51° 7.

It may be remarked that all observations in shafts thus far have exhibited irregularities of this kind. The water in such large openings seems to have its temperature governed by springs and other extraneous causes, rather than by the temperature of the surrounding soil.

The observations at every fiftieth foot of depth in the Kentish Town well, as given in previous reports, are so complete that it has not been thought necessary to continue them. A very delicate thermometer, reading by estimation to the $\frac{1}{100}$ of a degree, has however been procured, for taking observations from year to year at one constant depth (1,000 feet). It was constructed ten months ago, and being enclosed in a partially exhausted glass tube will probably not undergo much change of zero. It has been four times tested by comparison with standards, and has been found to have no error amounting to nearly so much as 0°·1. In consequence of Mr. Symons' illness, no observation has yet been taken with it in the well.

A thermometer which, through the breaking of a rope, had fallen into the mud at the depth of 1,090 feet from the surface of the ground, was extracted by Mr. Symons last November, more than a year after its fall. It had sustained no damage, and its indication when hauled up was 69°·4, nearly agreeing with the temperature previously observed at that depth.

In addition to the large numbers of thermometers above mentioned as having been issued during the past year, one has been furnished for observations which are to be made in the projected boring through the Wealden and underlying strata. With the exception of Mr. Symons' observations at Kentish Town (London, N.), we have as yet no observations of temperature from the Southern parts of England.

SECTION B—Chemical Science

Mr. Alfred Tribe read a paper *On the Precipitation of Silver by Copper*. In the course of experiments made in conjunction with the President, Dr. Gladstone, it was found that the silver obtained by precipitating the metal from the nitrate by means of copper always contained more or less of the latter metal. When an excess of silver remained in a solution only minute traces of copper were found, but as the silver solution became exhausted the proportion of copper rapidly increased. This co-precipitation of copper was shown to be due to the presence of atmospheric oxygen. In one experiment as much as 15 per cent. of copper was obtained after 48 hours exposure. When carbon dioxide was caused to bubble through the solution during the precipitation the quantity of copper deposited was greatly diminished. The author showed an eudiometric apparatus in which this property of absorbing oxygen was applied to determine the proportion of that gas in the air.

Mr. Gladstone gave a brief account of the physical and chemical characters of the *Volcanic Dust* recently ejected from Vesuvius. In some localities the fall of this dust was very heavy and extended over a considerable area: the sample examined was collected at Ischia, upwards of twenty-five miles from the mountain. It consisted essentially of a mixture of quartz and magnetite. No trace of titanium could be detected. Dr. Thorpe stated that he had recently examined the volcanic sand found in the neighbourhood of Etna, and its agreement in chemical and physical properties with the sand from Vesuvius was very striking. It also contained no titanium.

Dr. Schenck read a paper *On the Amount of Heat required to raise Elementary Bodies from the absolute zero to their state of fusion*. If we assume that a body at — 273° is completely deprived of heat it is possible to calculate the total heat in it at any other temperature provided that the specific heats of the body in its three states of aggregation, its latent heats of fusion and vaporisation, and its melting and boiling points are known. Such calculations are limited from the fact that only in the case of one body—water—are the data sufficiently well known. In the course of the paper the author pointed out a remarkable coincidence between cadmium, tin, and lead, in the amount of heat required to raise gram-equivalents from —273° to the state of fusion.

Mr. W. Lant Carpenter made a communication respecting the presence of *Albumen in Fats, and on a new method of obtaining Stearic and Palmitic Acids*. The paper mainly consisted of an account of Dr. Bock's remarkable process for the decomposition of Fats which is now being generally adopted on the Continent, in the manufacture of improved stearin candles. When fats are decomposed in the ordinary process by alkali, a considerable excess of the alkali above the theoretical quantity is required unless the operation is conducted under great pressure, when the risk of explosion increases the disadvantageousness of the process. When the fats are decomposed by oil of vitriol, or other strong acid (the method usually adopted in England), a considerable proportion of the fat is lost by being charred and burnt, and that which remains is so blackened that it is necessary to distil it, an operation of expense and of danger owing to the risk of fire or explosion. All these advantages are obviated by the use of Prof. Bock's process. Dr. Bock has shown that most neutral fats are made up of minute globules surrounded by albuminous envelopes, which form from 1 to 1·5 per cent. of the weight of the fat, and he considers that the action of the alkali, acid, or of heat or pressure was to break up these albuminous envelopes. The destroyed envelopes had a remarkable power of attracting the colouring matters contained in the fat or produced therein during the action of the acid or alkali. The existence of the albumen may be demonstrated by dissolving the fat in ether or benzol and adding water to the solution, or by boiling the fat with a strong solution of oxalic acid. In each case the albumen envelopes collect at the plane of juncture between the two liquids. In the new process the envelopes are broken up by the action of a small quantity of strong sulphuric acid for a limited time only and at a given temperature. The fat is then poured away from the destroyed envelopes and is ready for decomposition by water in open tanks. This operation requires some time for its completion; its progress may be readily determined by a microscopic examination of the crystallised fatty acid formed by slowly cooling a thin layer upon a glass slide. When the process of decomposition is at an end, the solution of glycerine is drawn off purified and concentrated for sale. The fatty acids thus obtained amount to 34 per cent. of the original fat: they are however far from pure and contain more or less brownish or black matter. By submitting the fatty acids in open tanks to the action of a dilute solution of certain oxidising agents, the dark coloured matters are partially oxidised and their specific gravity is so far increased that when the oxidation has proceeded far enough, they readily subside together with the envelopes to the bottom of the tank, and the supernatant fatty acids are rendered comparatively good in colour. After two or three repetitions of this process the resultant stearin is hot and cold pressed in the ordinary manner. The acid thus obtained is of a better quality, has a higher melting-point, and is yielded in greater quantity than that obtained in the ordinary way.

Mr. J. F. Walker contributed a paper *On Dinitrobrombenzene*, and Dr. Wright gave an account of the continuation of his experiments on *New Derivatives from Morphine and Codeine*.

Mr. John Williams described an improved method of preparing Guaranine, the active principle of *Guarana*, the fruit of the *Paulina sorbilis*, which is used by the Amazonian Indians for an infusion. This principle was isolated by Stenhouse, and pronounced by him to be identical with theine or caffeine, the active substance contained in tea and coffee. In the author's process the guarana is reduced to fine powder mixed with one-third of its weight of hydrate of lime and moistened with water. It is then allowed to stand for a couple of hours and thoroughly dried at a gentle heat. The mixture is exhausted with boiling benzol filtered, the benzol distilled off, when a small quantity of light coloured oily matter remains. This is treated with hot water and heated for some time over the water bath, filtered through a moist filter, and after concentration, the solution is set aside to crystallise. In about twenty-four hours the guaranine separates out perfectly pure. The same process is applicable to tea, but the author is inclined to believe that guaranine differs in several particulars—taste, solubility in water, &c.—from theine.

Mr. Wanklyn described a method of analysing the *Compound Ethers*—acetic ether, for example. It consisted in determining the amount of alcohol liberated in the decomposition of the ether by the known methods of alcoholimetry. The complete proximate analysis of a compound ether is thus rendered possible.

Prof. Crum-Brown made a brief communication on the subject of *Chemical Nomenclature*. Setting aside the trivial or proper names (names which are simply arbitrary words or marks each indicating in virtue of a convention applicable to each individual case, a particular substance), there are two systems or kinds of systems of chemical nomenclature. These may be distinguished as 1st, the composition system, and 2nd, the functional or relational system, or class of systems. In the first the name of a compound indicates the elements or radicals contained in it, and sometimes their proportions. Thus Chlornatrium, Chloriod, Dreifach chloriod, Silicium wasserstoff, &c. In English we have few names so distinctly compositional in form (we have indeed, Zinc methyl and all the other allied names) but many of our names, although apparently functional in form, are really compositional. Thus, chloride of A means with us nothing more than, or different from, a compound containing the elements chlorine and A: and chloride of sodium, chloride of iodine, ter-chloride of iodine, siliciureted hydrogen, not only represent the same substances as the German names just quoted, but tell us neither more nor less about the substances than these German names do. On the other hand, functional names present the chemical relations between substances. We may take as examples such names as the anhydride, the amide, the aldehyde, the nitride of acetic acid. These derivatives of acetic acid contain no acetic acid, but they stand in certain definite relation to that substance, and he anhydrides, amides, aldehydes and nitrides of other acids stand in the same relation to them. What is still, notwithstanding the efforts of modern chemists, the common popular nomenclature of salts, although originally intended as a compositional nomenclature, might, with perfect consistency, be retained as a functional nomenclature. The objection to the term "muriate of soda" was that the substance so named contains no soda. But the amide of benzoic acid contains no benzoic acid. Soda contains oxygen; muriate of soda contains none (unless chlorine be an oxide), but the nitride of benzoic acid contains no oxygen, although the acid itself does. The name muriate of soda originally meant the *compound* of anhydrous muriatic acid, $2HCl - H^2O$, and anhydrous soda Na^2O – $(2HCl - H^2O) + Na^2O$. We may now, if we please, use the name to mean the result of the action $2HCl + Na^2O - H^2O$. If we do so, the name becomes a functional one, and the phrase "muriate of," or, what is neither better nor worse, "hydrochlorate of," expresses the complex operation. Addition of hydrochloric acid and simultaneous separation of water. Similarly, in the case of such names as sulphate of potash, nitrate of oxide of silver, &c., the phrases "sulphate of," "nitrate of" express the complete operations, addition of sulphuric, or nitric acid, and simultaneous separation of water.

While the old view that salts are compounds of anhydrous acids and anhydrous bases is now abandoned by most theoretical chemists, a relic of this view still remains in the most advanced systems of nomenclature, producing an inconsistency really inconvenient to the teacher and student.

The objection taken to the name hydrochlorate of soda was not only that the substance contains no soda, but also that it contains no hydrochloric acid. This objection is perfectly valid against the name as a compositional one, but does it not equally hold against the words sulphate, nitrate, acetate, &c.? If we are to have hydric sulphate and hydric acetate for sulphuric and acetic acids, why not hydric muriate for muriatic acid? That this question is not altogether an absurd one will be obvious if we consider that all chlorides are not muriates. Those substances which are by general consent called salts stand in a definite genetic relation to the corresponding acids (or the hydric salts of the series), and it is inconvenient to have the same general name —chloride—applied to substances which do stand in this relation to hydrochloric acid, and also to those which do not. We may divide the chlorides into two groups, very different in character in their extreme members, and gradually shading into one another. We may take chloride of sodium as a representative of the one, and the chloride of phosphorus as a representative of the other. Chloride of sodium is a muriate; the chloride of phosphorus might be better described. We may call the acids and acid anhydrides negative, the hydratic bases, anhydrous bases positive—arranged in a series, we find the series a continuous one from the most positive or basic oxides or hydrates to the most negative; it is however convenient to have a zero point, and it is no disadvantage if this zero point be an arbitrary one. When we come to express numerically the amount of positiveness or negativeness of these oxides and hydrates, it will be necessary to have a zero point, and a very convenient one is that which corresponds pretty nearly to the generally understood limit between bases and acids, and depends upon the direction in which the action takes place.

SECTION C.—Geology

On the Cambrian and Silurian Rocks of Ramsey Island, St. David's, by Henry Hicks, F.G.S.*

In a report to the British Association in 1866, by the late Mr. Salter and the author, Ramsey Island was mentioned as a part of the district which had been examined and a short description of the rocks exposed there was given. At that time three distinct formations in succession had been recognised, and also correlated by their fossil contents and lithological characters with the Lingula flags, the Tremadoc group, and the Arenig group. Since then the author has further examined these beds, and recently along with Messrs. Homfray, Lightbody, Kirshaw, and Hopkinson.

During these researches numerous new forms have been discovered in these rocks, and many additional and interesting facts observed. In a section at the north end of the island the following rocks occur in succession:—

1. *Lingula Flags.*—A series of hard silicious sandstones with grey flaky slate, about 600 feet in thickness, and containing *Lingulella Davisii* in great abundance but no other fossils save worm tracks and burrows, and some plant-like markings.

2. *Tremadoc Group.*—Bluish grey flag, and earthy grey rock of a tough texture, from 800 to 1,000 feet in thickness. Fossils are very abundant throughout the whole series, and nearly all the species as well as many of the genera are new. They comprise Brachiopods of the genera *Lingula*, *Obolella*, and *Orthis*, and Lamellibranchs of the genus *Ctenodonta*. There are also two species of *Orthoceras*, a *Theca*, a *Bellerophon*, an *Encrinite* and a star fish, and nine species of Trilobites belonging to the genera *Dikelocephalus*, *Conocoryphe*, *Niobe*, *Asaphus*, *Cheirurus*, and *Calymene*, and a supposed land plant named *Sophyton explanatum*. Some of these genera are characteristic of the Cambrian rocks, and others of the Silurian; and there are several forms which had not previously been discovered in rocks of so early an age. Until the discovery of these rocks at St. David's the Tremadoc group was supposed to be a local formation only.

3. *Arenig Group.*—A series of ironstained slates and flags, having a thickness of 1,000 feet. The fossils comprise Trilobites belonging to the genera *Asaphus*, *Ogygia*, *Oeglina*, *Trinucleus*, *Ampyx*, *Calymene*, and *Agnostus*; also a *Conularia*, *Theca*, *Orthoceras*, *Bellerophon*, *Lingula*, and *Orthis*, and about 20 species of Graptolites.

In this section the succession from the Cambrian to the Silurian rocks is probably better shown than at any other place in Britain.

SECTION D.—Biology

DEPARTMENT OF ZOOLOGY AND BOTANY

Second Supplementary Report on the extinct Birds of the Mascarene Islands, by Alfred Newton, F.R.S.

The speaker stated that a portion of the grant unexpended at the last meeting of the Association had been expended by his brother in a renewed examination of the caves in the island of Rodriguez. This has been conducted by Mr. George Jenner, lately Chief Executive Officer of the island. No detailed account could at present be given. Several missing parts of the skeleton of Pezophaps, and of additional remains of the large Psittacine bird, described from a single fragmentary maxilla by Milne Edwards as *Psittacus* (?) *rodericanus*. This may enable its affinities to be more exactly determined, and also allow more light to be thrown on *P. mauritianus* of Owen. A bird described by Leguat, and hitherto believed to be extinct, had been found still to exist, and had been described by himself as *Palæornis exsul*. The remains of a Ralline bird, considered to be allied to Ocydromus Milne Edwards, was disposed to identify with the "Gelinotte" of Leguat, the nature of which had hitherto only been a matter of guess.

Dr. Sclater said it was well to bear in mind that Rodriguez was one of the stations where it was proposed to place a staff of astronomers to observe the transit of Venus, and the opportunity of carrying on ornithological observation at the same time should not be lost sight of.

On the Perforating Instrument of Pholas candida, by Mr. John Robertson.

The author attributed the perforating action of the animal to a rasping effected by the rotatory movements of the shell and also by putting the valves together.

Prof. Allman said that the late Mr. Bryson, of Edinburgh, had observed the habits of the Pholas, and had come to the conclusion that the boring was effected by the foot charged with silicious particles and acting like the leaden wheel of the lapidary.

Mr. Gwyn Jeffreys was of opinion that in the whole of the perforating conchifera and some of the univalves the foot was the instrument of perforation. In *Cardium*, *Mactra*, and especially *Solen*, as well as other bivalve mollusca, the posterior extremity of the shell was shaped to receive the foot which worked like a gardener's dibble. In the case of *Pholas dactylus*, Mr. Caillaud thought that at Nantes the gneiss was perforated by the rasping action of the shell. Man might do this, but it was doubtful whether it could be accomplished in this way by the *Pholas*. In *Teredo navalis* he believed that, as Sellius had shown in 1733 in his work "De Teredine Marina," the foot was the sole instrument of perforation, and in this case the posterior extremity of the shell had a large excavation to receive the foot. Again, *Pholadidea* in a young state excavated by means of its foot, but afterwards the aperture was closed by gelatinous matter, the animal became encysted, and no further excavation took place. The limpet he had seen in Aberdeenshire excavate the rock to the depth of a fourth of an inch, and this could only have been accomplished by the foot. In *Pholas* also no part of the shell can act at the bottom of the excavation. The prickles it was supposed were renewed; but this could not take place throughout the shell, and many excavating shells had no prickles at all. Deshayes had advocated the chemical theory; but this too had been exploded, as Deshayes himself admitted.

Summary of Flowering Plants of Sussex, by W. B. Hemsley.

Taking Babington's Manual (5th Edition) as a standard, the Flora of Sussex includes 1,059 species of flowering plants, reckoning Ferns and Horsetails as well. These last amount to only 33, or about 3 per cent. Roughly speaking $\frac{3}{4}$ are Dicotyledons and $\frac{1}{4}$ Monocotyledons; $88\frac{1}{2}$ per cent of the species are herbaceous, and $11\frac{1}{2}$ woody; $27\frac{1}{2}$ per cent are annuals, and $72\frac{1}{2}$ perennial; 12 natural orders include rather more than half the whole number of species; 76 of the species are maritime, and 56 peculiar to the chalk. *Pyrola media*, *Habenaria albida*, and *Festuca sylvatica* are outliers of Watson's Scottish type not found in adjacent counties. The three species peculiar to Sussex, *Phyteuma spicatum*, *Lonicera Xylosteum*, and *Trifolium stellatum* are probably all introductions, the last being certainly so. In the centre of the county the heath grows as high as three or four feet, and covers considerable tracts of land.

Prof. Lawson in answer to a speaker who had inquired the useful purpose of these investigations into indigenous plants, and who had lamented the want of adequate knowledge how to keep them in their place, pointed out that the researches of Messrs. Lawes and Gilbert were likely to lead to practical methods of developing the useful constituents of pasture and of restraining the growth of the undesirable elements. He was especially struck with the presence of *Centaurea calcitrapa* about Brighton. This he had generally seen as a ballast plant, and thought almost certainly an introduction.

Diversity of Evolution under Uniform External Conditions, by Rev. John T. Gulick.

The terms "Natural Selection" and "Survival of the Fittest" present different phases of a law which can act only where there is variation. Does this variation ever produce from one stock distinct varieties and species, while the external conditions remain the same? When a species is subjected to a new set of conditions, does the change that is brought about in the organism expend itself in producing just one new species completely fitted to the conditions, or may it produce many that are equally fitted? Facts in the geographical distribution and varia-

*The discussion referring to this paper occurs at p. 383 (after Mr. Hopkinson's paper.)

tion of the terrestrial molluscs of the Sandwich Islands seem to throw light on the subject. A forest region on the island of Oahu, 40 miles in length, and 5 or 6 miles in breadth, furnishes about 175 species, represented by 700 or 800 varieties. The average area occupied by each species is about 5 or 6 square miles, though many are restricted to half that area. The valleys that lie on one side of the mountain range that traverses this district preserve, as far as we can observe, the same conditions; but the varieties, and in some cases the species, found in each valley, differ from those found in any other.*

If we would account for these facts on the hypothesis of evolution, it seems necessary to suppose: First, that these molluscs possess an inherent tendency to variation, so strong that all that is needed to ensure the divergence of type in the descendants from one stock is to prevent, through a series of generations, their intermingling with each other; and secondly, that either the tendency to variation in this family is very much greater than usual, or their tendency to migrate weaker, and their opportunities fewer than usual. An investigation of the conditions under which that species exist leads me to believe that the smallness of the areas occupied by each is due to freedom from that competition that retards variation in Continental species, rather than to any deficiency in the means of transportation. On the continents, "Natural Selection" arising from severe competition with species that have a wide range, tends to prevent the development of varieties, and to give a wider diffusion of forms, that would otherwise be limited in their range, and variable in their type.

Mr. Wallace agreed with the Rev. J. T. Gulick in his interpretation of facts which appeared to be exceedingly remarkable. He had had the opportunity of working at a limited group of organisms in a small part of the world. The results he had described were a type of what took place over whole continents, and exhibit an example of variation and geographical distributions, perhaps the most remarkable that occurs on the surface of the earth. With the general principle that variation does not depend on difference in external condition, he altogether agreed. He thought in this matter that there was a confusion of two distinct things, even in some cases by Mr. Darwin himself. Variation was confounded with the formation of varieties. That it was not dependent on the change of conditions was evidenced by the fact that the varieties of domestic animals and plants were not due to this cause, but only to advantage being taken of spontaneous variation and identical conditions. Horticulturists obtained new varieties of any plant that was introduced into cultivation by growing it upon a very large scale, and selecting the sports which were sure to occur. In this case variation was accumulated by artificial selection, just as it is accumulated in nature by natural selection. This requires, as a condition of its action, a change of external conditions. We all know that closely allied, though distinct species, were found inhabiting distinct areas—for example, islands; and with large continental areas it was the same. This had led to the very general idea that it was variation of condition over those areas which had produced the varieties, whereas it had merely selected them. In the Sandwich Islands there was no difference of physical conditions adequate to produce this result. This was seen in the number of intervening forms which existed. It seemed due to the absence of any weeding-out effect. The land molluscs had hardly any competitors to struggle with, and no enemies, quadrupeds and reptiles being absent, and birds few. The rivers were small and would only distribute any form through the same valley. All these conditions favoured this remarkable persistence of closely linked forms.

SECTION G—Mechanical Science

On Rolling in a Seaway, by Mr. W. Froude, F.R.S.

This was a description of an apparatus for automatically recording the rolling of a ship in a seaway and the slopes of the waves.

The fundamental principles on which the performance of the apparatus depends are (1) that when waves act on a ship or other floating body which would stand stably upright in still water, she will be for the moment in equilibrium if upright or normal to the mean or effective slope of the wave which she occupies; and if she possess a given righting force when inclined to a given angle in still water, she will be urged by approximately the same righting force towards the normal position in wave water, if she at any moment deviate from it by the same inclination. (2) A plumb line or pendulum, if its point of suspension be at or very near the ship's centre of gravity, will be for the moment in equilibrium if it occupy the normal position, and if it have a very short period of oscillation it will instantly assume that position throughout the changes of the wave slope. These two propositions are but expressions of the interdependence which exists between the change of translatory motion which at any moment affects a mass or particle of matter, and the direction at the same moment proper to any force-direction-index carried by the man, whether it be a plumb-line, which lies in the direction, or a spirit level, which lies at right angles to it; the direction being simply the resultant of gravity, and of the disturbing forces which at the moment affect the mass. Mr. Froude described his apparatus as follows:—A revolving cylinder covered with paper and turned by rough clockwork receives the marks made by several pens. One of these pens records time, jerks being given it at successive equal intervals by an exact clock. The apparatus being placed at the centre of gravity of the ship, a pendulum of very short period and considerable power, oscillating in the plane transversely with the keel, records continuously by a second pen the angles made at each moment by the ship, with the mean or effective wave slope, that is to say, her relative inclinations. Another pen, actuated by a rocking arm kept level by the observer on deck, who points it to the horizon, records the angle made at the same moment by the ship with the horizon, that is to say, her absolute inclinations. From the records thus obtained, the amount of the roll of the ship with regard to the wave slope is at once shown, and the form of the wave can be easily worked out graphically, the wave slope at each moment being simply the difference between the records produced by the pendulum pen and the horizon pen respectively. But the graphic integration of the results supplied by the pendulum pen, if correctly performed, supplies what might be called the theoretical measure of the oscillations, which the ship ought to have performed with regard to the horizon during the period embraced in the record. For the pendulum record itself supplies, throughout, a measure of the accelerating force by which the ship's oscillation is governed; so that the integration of this gives a diagram representing the angular velocity which the ship should theoretically have acquired under the operation of that force. And the integration of the velocity diagram in turn gives the sequence or total of motions which the varying velocity involves. The performance of these integrations involves indeed a correct knowledge of the ship's dynamic constants, but these, so far as they are not already known by calculation, may be readily obtained by a single experiment with the ship in still water, where, if she be artificially brought into oscillation (an operation easily performed), and the instrument be made to record the oscillations as they subside under the influence of resistance, the natural period of her oscillation is at once known, and the coefficient of resistance is deducible in a shape which is approximately applicable to the ship's seaway oscillation, All the conditions required for the integration are thus supplied. Several series of diagrams thus obtained by the oscillation of ships in a seaway have been thus integrated, and the theoretical oscillations accord so completely with the recorded oscillations that the fundamental elements of the theory of rolling have been most satisfactorily verified. Mr. Froude said he had more recently contrived and executed an apparatus which would substitute an automatic record of the ship's absolute inclinations for that supplied by the observer on deck, as above described. For this purpose he employed a heavy stationary wheel, which was so delicately supported as to be incapable of receiving any rotation from the motion of a ship. This wheel, if placed transversely in the ship, would remain still at rest—that is to say, without rotation—and would thus, while the ship performed oscillations of rotation under it, communicate to one of the tracing pens a virtual motion along the record cylinder, so as to form a continuous record of the ship's absolute inclinations. The wheel is 3 ft. in diameter and 200 lb. in weight. Through the boss is carried out a strong steel axis, the prolonged ends of which are coated with hardened steel. The axis thus prolonged rests between two pairs of rocking arms, the ends of each pair forming a kind of V. The ends of the arms are, in fact, hardened steel plates, forming segments of circles struck from the axes or centres on which the arms rock, so that they are virtually portions of the circumferences of very large friction rollers. In order still further to reduce the friction of the working parts, the axes of

* A fuller statement of the fact has been given in an article on "Variation of Species related to their Geographical Distribution," in NATURE July 18th, 1872.

the rocking arms have been finally reduced to hardened steel pins of small diameter, and so mounted that their motions, when of small range, should be rolling not sliding motions, and great delicacy is thus obtained. The centre of gravity is brought to within 0·0065 in. of the axis of suspension, and the time of a single swing is over thirty-five seconds. Yet so great is the delicacy of the suspension, a weight of $\frac{1}{250000}$ part of that of the wheel itself, if placed at its extreme radius, will produce an oscillation of $1\frac{1}{4}$ in, in range, and which will continue for many minutes; or if the wheel be moved 90° from its position of rest, the oscillations will continue for nearly twenty minutes, the movement being so slow and solemn as to impress on the mind of an observer who had not seen it put in motion that the action was self-originated, or induced by some mysterious agency. The oscillation of a ship can scarcely communicate any motion at all to the wheel, and any minute rotation which is, in fact, communicated will assume the form of an oscillation, having so long a "period" that its effects will be easily separable from those proper to the oscillation of the ship. Thus the indications will be more exact than those produced by the rocking arm on deck. This improved apparatus has not yet been tried, but is ready, waiting a suitable day for trial on board a ship at Plymouth.

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