that concerning the origin of species, as any two problems can well be; and it does not devolve upon a writer to speculate upon the one, merely because he has solved the other. Those who have taken the greatest interest in Mr. Darwin's illustrious career cannot have failed to appreciate the admirable forbearance he has always displayed in not allowing himself to digress into collateral topics, however great the temptation to digress may be. All his vast and numerous conquests of thought have been achieved by a rigid adherence to the philosophy of fact; there is a grand consistency in the maintaining of a method, according to which pure speculation is nowhere permitted to assert itself, excepting in so far as it is absolutely necessary. Surely it would be a deplorable thing were "the epoch-making book" allowed to present a gratuitous deviation from this method, merely in order to plunge into a sea of *à priori* conceptions where inductive verification is as yet impossible. The passage quoted by Prof. Tyndall is adduced by Mr. Darwin only in order to show that *so far as the doctrine of the transmutation of species is concerned*, the evolution theory supplies us with "just as noble a conception of the Deity" as does the theory of special creation. Regarding the more ultimate question, everyone must say with Dr. Tyndall, "What Mr. Darwin thinks of the introduction of life I do not know;" and this, I take it, is just the condition in which the author of the "Origin of Species" should allow his opinions to take their place in history. In short, those who censure Mr. Darwin for his praiseworthy reticence regarding "the far higher problem of the essence or origin of life, upon which science as yet throws no light," * would do well to consider the beautiful example of scientific caution that is afforded by the manner in which this very subject is treated of in the concluding pages of the last edition of the "Origin;" and I am sure that I am only expressing the opinion of the majority of Mr. Darwin's admirers when I say, that whatever our ontological views may happen to be, we all unite in sincerely hoping that, in subsequent editions, he will not spoil the splendour of his finished work by indulging in speculations as foreign to his subject as they must be unprofitable in themselves.

Aug. 21 A DISCIPLE OF DARWIN

Meteors

ON referring to my record of meteors for the 8th inst., I find two meteors nearly at the times mentioned by Prof. Tait (vol. x. p. 305), viz., 10.33 and 10.53. That at 10.33 was, from its position as seen here, unquestionably *not* identical with the one he saw. That at 10.53 may possibly be the same, if by Monoceros Prof. Tait means the constellation commonly marked at Equuleus. If such is the case, a calculation, rough as the data necessitates, would give for the meteor's height at the beginning 144 miles; at the end, 87 miles.

I have of course had to assume a path for the northern station, but as the radiant point was indicated, and one point of the meteor's course, I had not much choice in the matter.

Birmingham, Aug. 24 THOS. H. WALLER

ANOTHER NEW COMET

THE following communication, dated Mr. Bishop's Observatory, Twickenham, Aug. 20, has been sent to the *Times* by Mr. J. R. Hind, F.R.S.:—

"We have received to-day from M. Stephan, director of the Observatory at Marseilles, telegraphic notice of the discovery of a comet this morning by M. Coggia, in the constellation Taurus, the position of which is thus given:—

"August 19, at 14h. 33min. mean time at Marseilles.—Right ascension, 59° 29′; Polar distance, 62° 55′. Motion towards the south-east. The comet is faint.

"The comet discovered at the same observatory by M. Borrelly, on the 25th of July, I observed here last night as follows:—

"August 19, at 9h. 27min. 38sec. mean time at Twickenham.—Right ascension, 13h. 32min. 7·58sec.; Polar distance, 17° 21′ 42·3″.

"It does not appear, as yet, to have materially decreased in brightness."

* "Origin of Species," p. 421, 1874.

THE BRITISH ASSOCIATION AT BELFAST

BELFAST, *Tuesday Night.*

BELFAST is quite the centre of Irish industry, and one of the most progressive towns in the kingdom. People are living who remember it with less than 20,000 inhabitants; now it has near 200,000. As a proof of industry and thrift, it offers a good example to the rest of Ireland. The Association has not met under very favourable circumstances, for unfortunately at this moment no less than 20,000 men in the town are on strike, and somewhat less than 15,000*l.* a week is withdrawn from circulation. A smaller town with a less elastic population would be paralysed, and the influence of the strike is sufficiently felt as it is. The population of the town is very mixed; it is not true Irish. Belfast is less Irish either than Dublin, Cork, Galway, Derry, or Limerick. There is a large leaven of Scotch and Scoto-Irish, who have indeed the merit of a thrifty nature, but who lack many of the good qualities of the Irish; among others, their hospitality. The thrift of these people has caused the hotel and lodging arrangements to be carried out in an abominable manner. We have been shamefully fleeced. One hotel charges a sovereign a night for a bedroom, others half as much; in any case, members of the Association are charged at least double the ordinary prices. In final despair we were driven to inquire at a small coffee-shop whether they had a room; the people replied that they had; but that if we were a member of the Association we must pay ten shillings a night, the ordinary price in that house being about two shillings. When people travel from a distance, and sacrifice time, money, and rest, to do the work of the Association, and not as pleasure seekers, it is rather hard to be swindled because you happen to be a member of the Association.

The Sections have been well filled, and have had plenty of pabulum in the form of papers and verbal communications. Section A has been divided into two Departments, and it is probable that one or two of the Sections will have to sit on Wednesday. The addresses were quite up to the average. Among the more interesting papers were those of Mr. Huggins, On the Spectrum of Coggia's Comet; Prof. Wiedemann, On the Magnetisation of Chemical Compounds; Dr. Carpenter, On the *Challenger* Deep-sea Dredgings; and Mr. E. J. Harland, On a Screw-lowering Apparatus for Ships. The expected fight about the *Eozoön Canadense* did not come off. The specimen and apparatus room is well filled. Among the more interesting objects we observe Prof. Barrett's apparatus for showing the elongation of iron, cobalt, and nickel by magnetisation, Mr. Braham's heliostat and ruled glass used in experiments on light, and Mr. Roberts' illustrations of columnar structure, artificially produced. The Thursday *soirée*, on the other hand, was singularly devoid of exhibitions of any kind, and the Ulster Hall was extremely crowded, both causes tending to make the evening drag rather heavily. There were several excursions on Saturday, and there are many prepared for Thursday, the principal being to the Giants' Causeway. The Mayor, who has throughout been very active in forwarding the interests of the Association, has issued invitations for a trip round the coast on Thursday, for which purpose he has engaged one of the fine Fleetwood mail steamers.

The Association meets next year at Bristol, Sir John Hawkshaw, C.E., F.R.S., being President-elect; Glasgow is to be the place of meeting in 1876, an influential deputation having attended the Association to urge upon it the claims of that city to the honour of its presence. Plymouth will probably be the rendezvous for 1877.

The following is the financial statement of the Association for the past year:—

RECEIPTS.

	£	s.	d.
To balance brought from last account	£924	15	10
Life Compositions at Bradford Meeting, and since	358	0	0
Annual Subscriptions do. do.	646	0	0
Associates' Tickets do. do. ...	796	0	0
Ladies' Tickets do. do.	601	0	0
Dividends on Stock	237	10	0
Sale of Publications	21	18	1
Balance of Grant made at Brighton to the Sewage Committee	26	8	7
	£3,611	12	6

PAYMENTS.

				£	s.	d.
Expenses of Bradford Meeting, also sundry Printing, Binding, Advertising, and Incidental Expenses ...				£373	8	4
Printing, Engraving, &c., Report of 42nd Meeting (vol. 41), Brighton				696	13	10
Ditto on Account of Report of 43rd Meeting (vol. 42), Bradford				58	13	5
Salaries (one year)				462	6	0
Rent and Office Expenses (Albemarle Street) ...				104	5	0
Grants made at Bradford Meeting, viz. :—						
Zoological Record				100	0	0
Chemistry Record				100	0	0
Printing Mathematical Tables				100	0	0
For Committee on—						
Elliptic Functions				100	0	0
Lightning Conductors				10	0	0
Thermal Conductivity of Rocks				10	0	0
Anthropological Instructions, &c... ...				50	0	0
Kent's Cavern Explorations				150	0	0
Luminous Meteors				30	0	0
Intestinal Secretions				15	0	0
British Rainfall				100	0	0
Essential Oils				10	0	0
Sub-Wealden Exploration				25	0	0
Settle Cave Exploration				50	0	0
Mauritius Meteorological Researches ...				100	0	0
Magnetisation of Iron				20	0	0
Marine Organisms				30	0	0
Fossils, North-west of Scotland				2	10	0
Physiological Action of Light				20	0	0
Trades' Unions				25	0	0
Mountain Limestone Corals				25	0	0
Erratic Blocks				10	0	0
Dredging, Durham and Yorkshire ...				28	5	0
High Temperature of Bodies				30	0	0
Siemens's Pyrometer				3	6	0
Labyrinthodonts of Coal-Measures				7	15	0
Widow of W. J. Askham				50	0	0
Aug. 19, Balance at Bank ...	£698	10	5			
Ditto in hands of General Treasurer	15	19	6			
				714	9	11
				£3,611	12	6

SECTION B

CHEMICAL SCIENCE.

OPENING ADDRESS BY THE PRESIDENT, PROF. A. CRUM BROWN, M.D., F.R.S.E., F.C.S.

ONE hundred years have elapsed since the discovery of oxygen by Priestley. Perhaps we should say rediscovery, for there is no doubt that about one hundred years earlier Mayow prepared from nitre nearly pure oxygen, and observed and recorded some of its most marked properties. Mayow's discovery, however, led to nothing, while Priestley's was the most important step in that reconstruction of speculative chemistry which was commenced by Black and carried on with surprising energy and thoroughness by Lavoisier and his associates. I shall not detain you by enumerating the ways in which this discovery has affected chemistry both practical and speculative. The pre-eminent position to which oxygen was at once elevated, and which it so long retained, makes this altogether unnecessary. I wish, however, to point out one character of the phlogistic controversy which sharply distinguishes it from many others. The truth represented by the theory of Phlogiston was not recognised with sufficient distinctness by the supporters of that theory to give them any chance of success in opposition to a band of devoted adherents of a view which was clearly understood by all. The phlogistists were completed defeated, and the theory ceased to exist. It has been left for chemical antiquaries to pick out, with difficulty and uncertainty, a meaning from the ruins.

I have mentioned this character because I wish to draw your attention to another more recent controversy, the result of which was very different.

The questions as to chemical constitution raised about forty years ago by Dumas and the new French school, in opposition to Berzelius, may now be said to be practically settled. The great majority of chemists are agreed as to what is to be understood by chemical constitution, and also as to the nature and amount of evidence required in order to determine the constitution of a substance. How has this agreement been produced? Some historical writers seem to wish us to believe that it is the result of the triumph of the ideas of Dumas, Gerhardt, and Laurent, and the defeat of the dualistic radical theory of Berzelius; that the arguments of Berzelius and his followers were only useful as giving occasion for a more full and convincing proof of the unitary substitution theory than would otherwise have been called for; that, in fact, the adherents of dualism played the part (not unfrequently supposed to be that of the Conservative party in politics) of checking and criticising the successive developments of truth, and thus allowing them time to ripen.

In opposition to the view thus broadly stated, I would place another, and for the sake of contrast shall state it also in perhaps too broad a form :—That the two theories, the dualistic radical theory and the unitary substitution theory, were both true and both imperfect, that they underwent gradual development, scarcely influenced by each other, until they have come to be almost identical in reference to points where they at one time seemed most opposed.

I have said that the development of the one theory was scarcely influenced by that of the other. Of course the *facts* discovered by both parties were common property, and the development of both theories depended upon the discovery of these facts; but the explanations of facts and the reasoning from them given by each party seemed to the other scarcely worthy of serious consideration, and were treated as matter of ridicule. And the habit of mind created by this mode of viewing the opposed theory rendered it difficult for those who were engaged in the controversy on either side to see how nearly the two theories have now come to coincidence. Their language still remains different; but as the facts are the same for both, it is not difficult for a neutral critic to translate from the one to the other; and if we do so we shall see that there is much real agreement between the two modes of representing chemical ideas, historically derived, the one from Berzelius, the other from Dumas, Laurent, and Gerhardt.

In both, chemical constitution is regarded as *the order in which the constituents are united in the compound*; and the same fundamental notion is indicated in the one by reference to proximate constituents, in the other by the concatenation of atoms. To show that this is so, and that the fundamental notion can be arrived at from the dualistic as well as from the unitary starting point, I shall cite an illustrative case. Every student of chemical history will remember the view of the constitution of trichloracetic acid propounded by Berzelius, and afterwards supplemented by a similar view of the constitution of acetic acid and an explanation of the likeness of some of the properties of these two substances. This has sometimes been spoken of as a subterfuge of a not very creditable kind, by means of which Berzelius apparently saved his consistency while really yielding to the arguments of his opponents. But if, instead of looking at it in the light of the substitution controversy, we consider it in itself as a contribution to speculative chemistry, we at once recognise in it a statement, in Berzelian language, of the views we now hold as to the constitution of these acids. The view was that acetic acid is a compound of oxalic acid and methyl, trichloracetic acid a compound of oxalic acid and the sesquichloride of carbon. They differ considerably from each other, because the "copulæ" (methyl and sesquichloride of carbon respectively) are different; but their resemblance is strongly marked, because they contain the same active constituent, oxalic acid; and most of the prominent characters of the substances depend upon it, and not upon the copulæ. Let us first free this statement from what we may call archaisms of language. It will then assume something like the following form :—The carbon in acetic acid is equally divided between two proximate constituents, one of which is an oxide, the other a hydride of carbon. Trichloracetic acid similarly contains an oxide and a chloride of carbon, between which the carbon is equally divided. The oxide is the same in both acids, and is that oxide which occurs in oxalic acid. The hydride and the chloride have the composition of the substances, the formulæ of which are C_2H_6 and C_2Cl_6 respectively. Oxalic acid undergoes chemical change much more readily than the corresponding hydride or chloride; and therefore the chemical character of acetic and of trichloracetic acids depends much more on the oxidised than on the other constituent, and they thus have a marked resemblance. The oxidised constituent is united to the other in a manner different from that in which oxalic acid is united to bases in the oxalates, inasmuch as, while the basic water of hydrated oxalic acid is displaced when oxalic acid unites with a base, in hydrated acetic and trichloracetic acids there is the same proportion between the basic water and the oxidised carbon as there is in oxalic acid.

Now, has not this a great resemblance to the view entertained by most modern chemists, that acetic acid is a compound of the radical carboxyl (half a molecule of oxalic acid) and the radical methyl (half a molecule of methyl gas), that trichloracetic acid similarly contains the same radical carboxyl and the radical $C\,Cl_3$, and that the prominent chemical properties of these bodies depend upon their containing carboxyl, and that they therefore resemble each other?

The modern view contains nothing inconsistent with that of Berzelius; but it no doubt contains something more: it contains an explanation of the difference between the manner in which carboxyl is united to methyl in acetic acid, and the manner in which oxalic acid is united to bases in the oxalates. But it will surely be admitted that Berzelius was here far ahead of his opponents—so far ahead, that they altogether failed to see his meaning, and looked upon his argument as a clumsy device.

The treatment by Berzelius of the constitution of the sulpho-acids, furnishes a precisely similar case. These are now regarded as compounds of the radical SO_2OH (which we may call sulphoxyl). This radical is half a molecule of hyposulphuric acid; and Berzelius considered them coupled compounds of hyposulphuric acid, adopting at once the view first brought forward by Kolbe in his classical memoir on the sulphite of perchloride of carbon and the acids derived from it.

I might pursue the history of the carbon- and sulpho-acids further, and trace the development of the theory of their constitution through the discoveries of Kolbe, and his beautiful application to the cases of carbon and sulphur of Frankland's far-sighted speculation on the constitution of the organo-metallic bodies, pointing out the relation of Kolbe's views of the constitution of acids, alcohols, aldehydes, and ketones, to the Berzelian theory on the one hand, and to the opinions of modern chemists on the other; but the greater part of such an historical sketch has been given very recently by Kolbe himself in the *Journal für praktische Chemie*, and I may therefore omit it.

It would be easy to bring forward cases to show that our present views can be directly derived from the substitution theory and the types of Dumas and Gerhardt, through the complications of multiple and mixed types, and the labyrinthine formulæ to which these gave rise, to the wonderfully simple and comprehensive system of Kekulé; but that is unnecessary, as this development has been fully and ably described by more than one thoroughly competent writer.

We have been discussing a case in which Berzelius was right in considering a compound of carbon, oxygen, and chlorine as composed of two parts—an oxide and a chloride of carbon. It is only just that we should only take some notice of cases, at first sight similar, in which modern chemists would be inclined to think that he was wrong. This is the more necessary, as an examination of these cases will enable us to see what was the really valuable contribution made to speculative chemistry by the substitution theory.

Compounds containing three elements were formulated in two different ways by Berzelius:—

1. One of the elements was represented as combined with a radical composed of the other two, as—hydrocyanic acid, $H_2 \cdot C_2N_2$; ether, $C_4H_{10} \cdot O$.

2. The ternary compound was represented as composed of two binary compounds, having one element common, as—caustic potash, KO, H_2O; chromochloric acid, $2CrO_3, CrCl_6$.

Phosgene gas was at first formulated in the former of these ways as CO, Cl_2; but latterly he was forced, in consistency, to give up all radicals containing oxygen or other strongly electro-negative element,* and to write the formula of phosgene gas CO_2, CCl_4. Similarly, in every case where a positive element or radical is combined with two negative elements or radicals, he represented the compound as composed of two binary compounds, thus—chloride of acetyl, $2C_4H_6O_3, C_4H_6Cl_6$, as a compound of acetic acid and the corresponding terchloride.

This was in perfect consistency with the mode in which ternary compounds containing one negative and two positive elements or radicals were formulated, as caustic potash, KO, H_2O, sulphate of copper, CuO, SO_3, &c.; but it lacks the practical justification which can be given for the formula C_2H_6, C_2O_3 for acetic acid; for phosgene acts readily on water, forming carbonic and hydrochloric acids, an action which does not take place with perchloride of carbon; and it is not easy to see why the latter substance should be more readily attacked by water when combined with carbonic acid than when free. This difference did not escape the attention of Berzelius, and led him to distinguish two modes of chemical union: (1) where the constituents were held together by the electro-chemical force, and wholly or partially neutralised each other, as in the oxygen and sulphur salts; and (2) where a so-called "copula" was attached by an unknown force to a substance without greatly modifying its chemical activity. The distinction seems arbitrary; but it was not, as is usually supposed, a mere artificial bulwark to protect the electro-chemical theory; it has a real and very important meaning, a meaning which the development of the substitution theory enables us to explain.

The phenomena of electrolysis, upon which the Berzelian system is based, bring forward into great prominence *one* of the chemical units, viz. the *equivalent*; and the pre-eminent position of oxygen as the most electro-negative element made it most natural to select the atom of oxygen as the standard of equivalence, so that an equivalent of any element or radical was defined as that quantity of it which is equivalent to one atom of oxygen. Gay-Lussac's law of gaseous volumes, which was adopted by Berzelius, and which, by a curious accident, happens to be true for all elements gaseous at ordinary temperatures, led to the formulæ H_2 and Cl_2 for the *equivalents* of hydrogen and chlorine; but although these formulæ explicitly indicate the divisibility of the equivalents of these elements, this divisibility was not recognised, and integral numbers of equivalents were alone tolerated. Thus hydrochloric acid was written H_2Cl_2, ammonia N_2H_6, &c., and the etymological meaning of the word atom was soon lost. The use of barred letters to indicate two atoms or one equivalent of such elements as hydrogen and chlorine further contributed to hide the important fact of their divisibility.

The first great result of the substitution theory was to change the unit of equivalence, and to take as the standard the atom of hydrogen or of chlorine instead of that of oxygen; and although it would be most unjust to forget the services of Dumas, Gerhardt, Laurent, and Odling in this matter, the credit of removing the bars from H, Cl, and their comrades, and allowing the hitherto chained partners to walk at liberty, undoubtedly belongs mainly to our distinguished colleague and master, Prof. Williamson.

The establishment of the water type, or (to put it in another form) the proof that the atom of oxygen contains two units of oxygen, inseparably united but capable of separate action, led the way to the explanation of all the difficulties which beset the theory of radicals and copulæ. It at once explained how two oxides or two sulphides unite together;* and the idea of "polybasic," or, as we should now say, polyad atoms and radicals, was soon used to explain the existence of polybasic acids, double salts, acichlorides, and many other kinds of ternary compounds.

But a fact does not cease to exist because it is explained. Quicklime and water unite together, although we can now explain how they do so; and a useful purpose may still be served by the enumeration, as in the old dualistic formulæ, of the pairs of united equivalents. Although some of these equivalents belong to the same atoms, it is nevertheless true that they are united in pairs. Caustic potash might thus be formulated, $KO\tfrac{1}{2}$, $HO\tfrac{1}{2}$ or $\tfrac{1}{2}(K_2O, H_2O)$; phosgene gas, $\tfrac{1}{2}(CO_2, CCl_4)$; and chlorochromic acid, $\tfrac{1}{3}(2CrO_3, CrCl_6)$. These formulæ are not so well suited for general use as those now current; but the consideration of them as accurate representations of facts may enable us to see that the copulæ of Berzelius had a real and valuable meaning. Take, for instance, the formula of acetic acid, $H_3C{-}CO{-}OH$, or $\tfrac{3}{4}CH_4, \tfrac{3}{4}CO_2, \tfrac{1}{2}H_2O, \tfrac{1}{4}C_2$; it is this last term which indicates the coupled character of the compound. If we look upon acetic acid as a compound of carbon, it is a coupled compound because

* In 1838 Berzelius was inclined to regard C_2O_2, to which he gave the name "oxatyl," as the radical of oxalic acid and oxamide.

* It does not explain the existence of double chlorides, bromides, &c. These compounds, apparently so similar to the double oxides and sulphides, are still unexplained.

all the equivalents of carbon in it do not belong to the same atom, and the two atoms of carbon are directly united together, and replacement of the equivalents united to one of these atoms does not very greatly affect the function or chemical character of the equivalents united to the other.

I have perhaps spent too much of your time upon these historical questions. Let us now shortly consider what is the present state of our knowledge as to chemical constitution. This I have already defined as the order in which the constituents are united in the compound. We may indeed use metaphorical language, and speak of the relative position of atoms, perhaps deluding ourselves into the notion that such language is more than metaphorical; but the phenomena of combination and decomposition, although we cannot doubt that they depend solely upon the relative position and dynamical relations of the atoms, are not alone sufficient to prove even that atoms exist. Our knowledge of the intimate structure of matter comes from another source—from the study of the properties rather than of the changes of substances, and of the transformations of energy which accompany the transformations of matter.

This is strictly a branch of chemistry: the aim of chemistry is to connect the properties of substances and the changes they undergo with their composition, taking this word in its widest sense; and we must not allow our friends in Section A to cut our science in two and appropriate the half of it. We all frankly admit that chemistry is a branch of physics; but it is so as a whole—no section of it is more purely physical than all the rest. To accept a narrower definition of chemistry is to reduce ourselves to the position which the collector occupies among naturalists; it is to admit that it is our business to provide part of the materials out of which a science in which we have no share may be constructed by others. But we need not fear that this so-called physical side of chemistry will ever be divorced from the study of chemical change. The names of Faraday and Graham among those who have left us, of Andrews among those who are still at work, are sufficient proof of this; and a study of their researches will conclusively show that great results can be looked for in this direction only from a physicist who is also a chemist.

There are three special directions in which such investigations have already influenced chemical theory:—1. *Electrolysis*, which has confirmed the equivalent as a chemical unit, has proved that equivalents unite in pairs, thus forming the basis of electro-chemical theory, and has shown us how to estimate the amount of energy involved in the union of a given pair of equivalents. 2. *Vapour-density*, from which Avogadro inferred the law of molecular volumes (since proved by Clerk-Maxwell), which has given us the molecule as a chemical unit, and formed the basis of the unitary theory. 3. *Specific heat*, from which Dulong and Petit inferred their empirical law, which gives us the most satisfactory physical definition of the atom as a chemical unit.

We naturally turn to the future, and try to guess whence the next great revolution will come. For although periods of quiet have their use, as affording time for filling up the blank schedules furnished by the last speculative change, such periods have seldom been long, and each has been shorter than its predecessor.

But it is impossible to make a certain forecast: looking back, we see a logical sequence in the history of chemical speculation; and no doubt the next step will appear, after it has been taken, to follow as naturally from the present position. One thing we can distinctly see—we are struggling towards a theory of chemistry. Such a theory we do not possess. What we are sometimes pleased to dignify with that name is a collection of generalisations of various degrees of imperfection. We cannot attain to a real theory of chemistry until we are able to connect the science by some hypothesis with the general theory of dynamics. No attempt of this kind has hitherto been made; and it is difficult to see how any such attempt can be made until we know something in reference to the absolute size, mass, and shape of molecules and atoms, the position of the atoms in the molecule, and the nature of the forces acting upon them. Whence can we look for such knowledge?

The phenomena of gaseous diffusion, of gaseous friction, and of the propagation of heat through gases, have already given us an approximation to the size and mass of the molecules of gases. It is not unreasonable to suppose that a comparative study of the specific heat of gases and vapours may lead to some approximate knowledge as to the shape of their molecules; and a comparison of such approximate results with the chemical constitution of the substances may lead to an hypothesis which will lay the foundation of a real theory of chemistry.

Chemistry will then become a branch of applied mathematics; but it will not cease to be an experimental science. Mathematics may enable us retrospectively to justify results obtained by experiment, may point out useful lines of research, and even sometimes predict entirely novel discoveries, but will not revolutionise our laboratories. Mathematical will not replace Chemical analysis.

We do not know when the change will take place, or whether it will be gradual or sudden; but no one who believes in the progress of human knowledge and in the consistency of Nature can doubt that ultimately the theory of Chemistry and of all other physical sciences will be absorbed into the one theory of Dynamics.

SECTION E

Geography

Opening Address by the President, Major Wilson, R.E.

The President of the Royal Geographical Society has so recently delivered his anniversary address, that if I were to attempt to trace the progress of geographical discovery during the period that has elapsed since the meeting of the British Association at Bradford in September last, I could scarcely avoid repeating much that has already been said in far abler terms than I have it within my power to command. Still there are, at the present moment, certain subjects of such very general interest and of so much importance that they cannot well be passed over in any address to the Geographical Section of the British Association.

It has, I believe, been usual in the addresses to this Section to select some special subject for remark, and I will therefore, if you will allow me, before alluding to the geographical achievements of the year, draw your attention to the influence which the physical features of the earth's crust have on the course of military operations; to the consequent importance of the study of physical geography to all those who have to plan or take part in a campaign; and to the contributions to geographical science that are due, directly or indirectly, to war, and the necessity of preparing for war. To show how varied are the conditions under which war has to be carried on, and how much its successful issue may depend on a previous careful study of the physical character of the country in which it is waged, it is only necessary to remind you of the recent operations on the Gold Coast, brought to a successful issue in an unhealthy climate, and in the heart of a dense tropical forest, where an impenetrable undergrowth, pestilential swamps, and deep rivers obstructed the march of the troops; of the Abyssinian expedition, landing on the heated shores of the Red Sea, and thence, after climbing to the lofty frozen highlands of Abyssinia, working its way over stupendous ravines to the all but inaccessible rock, crowned by the fortress of Magdala; of the march of the Russian columns across the steppes and deserts of Central Asia to the Khivan oasis, one month wearily plodding through deep snow, the next sinking down in the burning sand, and saved from the most terrible of disasters by the timely discovery of a well; and, lastly, of the great struggle nearer home, the last echoes of which have hardly yet passed away, when the wave of German conquest, rolling over the Vosges and the Moselle, swept over the various provinces of France. The influence of the earth's crust on war may be regarded as twofold: first, that which it exerts on the general conduct of a campaign; and, second, that which it exerts on the disposition and movement of troops on the field of battle. Military geography treats of the one, military topography of the other; and it is well to keep this broad distinction in view, for, as with strategy and tactics, they stand in such close relation to each other that it is not always easy to say where geography ends and topography begins. Of special importance in the first case are great inequalities or obstacles that confine or obstruct the movement of large bodies of troops, and those features that retard or accelerate their march. The climate of the theatre of war must always have an important influence on military operations, and should be the subject of careful study. Our own experience in the Crimea shows how much suffering may be caused by want of forethought in this respect. General Verevkin's remarkable march of more than a thousand miles, from Orenburg to Khiva, with the thermometer ranging from 24° below zero to 100°, without the loss of a man, shows what may be accomplished with due preparation. Nor should the geological structure of a country be over-looked in its influence on the varied forms which the earth's crust assumes, on the presence or otherwise of water, on the supply of metal for repairing roads, and, if we may trust somewhat similar appearances on the Gold Coast, at Hong Kong, and in the Seychelles, on the healthiness or unhealthiness of the climate. It is scarcely necessary to remind you that though mountain ranges and rivers materially affect the operations of war, they are by no means insurmountable obstacles. The Alps have been repeatedly crossed since the days of Hannibal; Wellington crossed the Pyrenees in spite of the opposition of Soult; Diebitsch the Balkan, though defended by the Turks; and Pollock forced his way through the dreaded Khyber; whilst there is hardly a river in the length and breadth of Europe that has not been crossed, even when the passage has been ably disputed. This is hardly the place to discuss the minuter details of military geography and topography: they will be found in the works specially devoted to the subject.

Queen Elizabeth's Minister was right when he said that "Knowledge is power;" and a knowledge of the physical features of a country, combined with a just appreciation of their influence on military operations, is a very great power in war. A commander entering upon a campaign without such knowledge may be likened to a man groping in darkness; with it he may act with a boldness and decision that will often ensure success. It was this class of knowledge, possessed in the highest degree by all great commanders, that enabled Jomini to foretell the collision of the French and Prussian armies at Jena in 1807, and in later years enabled a Prussian officer, when told that MacMahon had marched northwards from Chalons, to point unerringly to Sedan as the place where the decisive battle would be fought. As, then, all military operations must be based on a knowledge of the country in which they are to be carried on, it should never be forgotten that every country contiguous to our own—and the ocean brings us into contact with almost every country in the world—may be a possible theatre of war, and that it is equally the duty and policy of a good Government to obtain all possible information respecting it. Is it with much satisfaction that we can turn to the efforts made by this country to acquire that geographical knowledge which may be of so much importance in time of need? Though we had for years military establishments on the Gold Coast, and though we had more than once been engaged in hostilities with the Ashantees, and might reasonably have expected to be so again, no attempt appears to have been made to obtain information about the country north of the Prah, or even of the so-called protected territories. The result was that when the recent expedition was organised, the Government had to depend chiefly on the works of Bowdich, Dupuis, and Hutton, written some fifty years ago, and on a rough itinerary of the route afterwards followed by the troops, for their information relating to the country and its inhabitants. What advantage has been taken of the presence of the officers who have been in Persia during the last ten years to increase our knowledge of that country—knowledge which would be very useful at present in the unsettled state of the boundary questions on the northern and north-eastern frontiers? How little has been added to our knowledge of Afghanistan since the war in 1842? and what part did India take in Trans-Himalayan exploration before Messrs. Shaw and Hayward led the way to Yarkand and Kashgar? It was with feelings of no slight satisfaction that many of us heard last year that the policy of isolation and seclusion which India appears to have adopted as the last soldier of Pollock's relieving force recrossed the Indus was at last to be broken, and that an expedition well found in every respect was to be sent to Kashgar. It seemed an awakening from the long slumber of the last thirty years, during which we were content to stay at home in inglorious ease, resting under the shadow of the great mountain ranges of Northern India, whilst we sent out mirzas and pundits to gather the rich store of laurels that hung almost within our grasp. Far be it from me to depreciate the valuable services of those gentlemen—services frequently performed at great personal risk and discomfort; but who can compare the results they obtained with those that would have been brought back by English officers, or by travellers, such as Mr. Shaw, Mr. Ney Elias, and others? It has been said that if officers travelled in countries where Government could no longer protect them, they might be killed by the natives, and that then, if the murders were not punished, England would suffer loss of prestige. But is this the case? As a matter of fact, the number of travellers who lose their lives at the hands of the natives of the countries in which they are travelling is quite insignificant when compared with the number of hose who return in safety. Let us, then, hope that the Kashgar mission may date the commencement of a new era, during which geographical enterprise may be encouraged, or at any rate not discouraged, amongst the officers of the army, and if few will now deny that a knowledge of Ashantee, of Yemen, of the northern and north-eastern frontiers of Persia, of Merv, Andkhu, Maimana, Badakshan, and Wakhan, would have been of importance in the years just passed, it may not be forgotten that a knowledge of these countries may be of still more importance in a not far distant future. May we not take a hint in this respect from our now near neighbours in Central Asia, the Russians? No one who has followed their movements can fail to have been struck by the intense activity of their topographical staff—an activity that can only be compared to that of England at the period when Burnes, Eldred Pottinger, Wood, Abbott, Connolly, and others whose names are ever fresh in our memories, were penetrating into the wildest recesses of Central Asia. In alluding to the contributions of war to geographical science, it is perhaps hardly necessary to mention the very obvious manner in which military operations teach us geography by directing our attention for the time being to the country in which they are being carried on, or to the direct results that have followed many campaigns from the days of Alexander to our own. The Russians are indeed far in advance of us in all that relates to those survey operations and that geographical exploration which should always be carried on simultaneously with the advance of an expeditionary force into an unknown or but partially known country; they have long since realised the importance, almost necessity, of accurate geographical knowledge, based on sound systematic survey, and, having learned in time the lesson that opportunities once lost may never be recovered, make every effort to take advantage of those that are offered to them. In the expedition against Khiva each column had attached to it an astronomer and small topographical staff, whose duty it was to fix the geographical positions of all camps and map the route and adjacent country, whilst officers on detached duty were instructed to keep itineraries of their routes which might be fitted in to the more accurate survey. On the fall of Khiva an examination of the Khanate was at once commenced, and it was even thought necessary to send Col. Skobelof, disguised as a Turkoman, to survey the route by which Col. Markosof should have reached the oasis. It is much to be regretted in the interests of geography that some such system was not adopted during the recent operations on the Gold Coast, and that so little, comparatively speaking, has been added to our knowledge of Ashantee and the protectorate. The conclusion of peace with King Coffee, and the effect that must have been produced on the inland tribes by the destruction of Coomassie, appear to offer facilities for the examination of a new and interesting region which it is to be hoped will not be neglected by those who are able and willing to take part in the arduous task of African exploration.

The most important military contributions to geography have undoubtedly been those great topographical surveys which are either completed or in progress in every country in Europe except Spain, Turkey, and Greece. Frederick the Great was, I believe, the first to recognise that in planning or conducting operations on a large scale, as well as directing many movements on the field of battle, a commander should have before him a detailed delineation of the ground of a whole or part of the theatre of war. To supply this want, Frederick originated military topography, which, in its narrower sense, may be defined as the art of representing ground on a large scale in aid of military operations. It was found, however, that during war there was rarely sufficient time to construct maps giving the requisite information, and thus the necessity arose of collecting in peace such data as would enable maps to be prepared. In this necessity may be seen the origin of all national topographical surveys, including our own, which was commenced as a purely military survey in 1784 by General Roy, and transferred in 1791 to the old Board of Ordnance. The gradual development of these surveys, and the various stages through which they have passed before reaching their present state of excellence, need not be noticed here. Side by side with the large establishments engaged in the production of the topographical maps, there have grown up in most countries extensive departments, sometimes employing from fifty to sixty officers, whose duty it is to supplement the maps of their own and foreign countries by the collection of all information of whatever nature that may be useful in time of war. The brief interval that elapses between the declaration of war and the commencement of hostilities, the rapid movements of armies, and the short duration of campaigns at the present, have shown more clearly than ever the imperative necessity of previous preparation for war; and the publication of the great surveys of most European countries has given an impetus heretofore unknown to the studies I have alluded to.

The progress of the European surveys, and especially of our own, has been marked by many results which have indirectly influenced the advancement of geographical science. Such are the improvements in instruments made during the progress of the triangulation; the introduction of the Drummond light, Colby's compensating bars, &c.; the connection of the English and Continental systems of triangulation; the pendulum observations at various places; the measurement of arcs of the meridian; the comparison of the standards of length of foreign countries, of India, Australia, and the Cape of Good Hope, with our standard yard, which has recently been completed at the Ordnance Survey Office, Southampton. In the same category may be placed the improvements in the art of map engraving, in the application of chromo-lithography to the production of maps as exemplified in the Dutch process of Col. Bessier and the Belgian maps; and the employment of electrotyping to obtain duplicates of the original plates. The method of copying maps by photography without any error in scale, or any distortion that can be detected by the most rigid examination, was first proved to be practicable and was adopted in the Ordnance Survey Department in 1854, by Major-General Sir Henry James, for the purpose of facilitating the publication of the Government maps of the United Kingdom on the various scales. Since that date the necessity of rapidly producing, multiplying, enlarging, and reducing maps has tended towards the development of the various photographic processes which have been brought to such a high state of perfection. During the last five years photographic negatives on glass covering an area of 10,071 square feet were produced at the Ordnance Survey Office for map-making purposes alone, and from these negatives 21,760 square feet of silver prints were prepared and used in the various stages of the Survey. An area of 959 square feet of the negatives was also used in producing 13,595 maps on various scales by the photosincographic process, which was also introduced by Major-General Sir Henry James. It was by similar processes that the Germans were enabled to provide the enormous number of copies of the various sheets of the map of France required during the war of 1870-1. Any comparison of the maps of various countries would necessarily occupy much time, so I will only add that as specimens of engraving the sheets of our one-inch map are unrivalled, and that no foreign maps can compare for accuracy of detail and beauty of execution with the sheets of our six-inch survey. Our great national Survey is the most mathematically accurate in Europe, and it speaks much for the ability of the officers who have brought it to its present state of perfection, that from the very first they recognised the necessity of extreme scientific accuracy in their work, and that they have never had to withdraw from the position they have taken up with regard to the many questions of detail that have arisen from time to time.

Before concluding this portion of my address I would draw your attention to the appliances used in the minor schools of this country for teaching geography, as they would seem to need some improvement. The appliances to which I allude are models or relief maps, wall maps, atlases, and globes. The use of models as a means of conveying geographical instruction has been too much neglected in our schools. If anyone considers the difficulty a pupil has in understanding the drawing of a steam-engine, and the ease with which he grasps the meaning of the working model, and how from studying the model and comparing it with the drawing he gradually learns to comprehend the latter, he will see that a model of ground may be used in a similar manner to teach the reading of a map of the same area. Relief maps of large areas on a small scale have their uses, but they are unsuitable for educational purposes on account of the manner in which heights must be exaggerated to make them appear at all; this objection, however, does not apply to models of limited areas on a sufficient scale, which always give a truthful and effective representation of the ground. One reason why models have not been more used has been their cost, but the means of constructing them with ease, rapidity, and at slight expense, are quickly accumulating as the six-inch contoured sheets of the Ordnance Survey are published. Instruction in geography should begin at home, and I would suggest that as the six-inch survey progresses each decent school throughout the country should be provided with a model and a map of the district in which it is situated. If this were done, the pupils would soon learn to read the model, and having once succeeded in doing this, it would not be long before they were able to understand the conventional manner in which topographical features are represented on a plane surface, and acquire the power of reading not only the map of their own neighbourhood, but any map which was placed before them. In our wall maps I think we have been too much inclined to pay attention to the boundaries of countries, and to neglect the general features of the ground. It is difficult to say whether the maps have followed the teachers or the teachers the maps, but I fear instruction in physical geography too often comes after that in political geography, instead of a knowledge of the latter being based on a knowledge of the physical features of the earth. My meaning may perhaps be explained by reference to a wall map probably well known to everyone, that of Palestine, which frequently disfigures rather than ornaments the walls of our schoolrooms. In this map there are usually deep shades of red, yellow, and green to distinguish the districts of Judea, Samaria, and Galilee, and perhaps another colour for the Trans-Jordanic region, with a number of Bible names inserted on the surface, whilst the natural features are quite subordinate, and sometimes not even indicated. There is perhaps no book that bears the impress of the country in which it was written so strongly as the Bible; but it is quite impossible for a teacher to enable his pupils to realise what that country is with the maps at present at his disposal. The first object of a wall map should be to show the geographical features of countries, not their boundaries, and for this purpose details should be omitted, and the grander features have special attention paid to them. In school atlases the same fault may be traced, physical features being too often made subordinate to political divisions; and there is also in many cases a tendency to overcrowd the maps with a multitude of names which only serve to confuse the pupil and divert his attention from the main points. The use of globes in our schools should be encouraged as much as possible, as there are many physical phenomena which cannot well be explained without them, and they offer far better means of conveying a knowledge of the relative positions of the various countries, seas, &c., than any maps. The great expense of globes has hitherto prevented their very general use, but some experiments are at present being made with a view to lessening the cost of the construction, which it is hoped may be successful. I cannot pass from this subject without alluding to that class of maps which gives life to the large volumes of statistics which are accumulating with such rapidity. On the Continent these maps are employed to an extent unknown in this country, both for purposes of reference and education, and they convey their information in a simple and effective manner.

I will only detain you to notice briefly a few of the most important geographical events of the year, and foremost amongst these ranks the publication of Dr. Schweinfurth's work which every one has recently been reading with so much interest and pleasure. Dr. Schweinfurth, who received the Founder's medal of the Royal Geographical Society this year, is, I am happy to say, amongst us at present, and has contributed a valuable paper on the oases of the Libyan Desert.

Lieut. Cameron, R.N., has reached Ujiji, and extracts from a journal which he has sent home will be read to you. The observations which he has made are of high value, and the presence of a trained surveyor on the shores of Lake Tanganyika cannot fail to be followed by great results. A short report of Dr. Nachtigall's travels has been prepared for this Section; and Dr. Rowe, who acted as Chief of the Staff to Sir John Glover during his recent operations on the Gold Coast, will read an interesting paper on the country passed through on the march to Coomassie and thence to the coast. Two Engineer officers, Lieuts. Watson and Chippendale, have recently left England to join Col. Gordon at Gondokoro, with the special object of surveying the territory over which Col. Gordon has been appointed Governor by the Khedive. In Algeria the French have been actively engaged on the survey of the country, and the exact level of the Choltmil-Rhir has been determined. Mr. Stanley's second expedition to the east coast of Africa, under the auspices of an English and American newspaper, should not remain unnoticed, and I cannot pass from Africa without expressing my deep regret at the death of Dr. Beke, whose travels in Abyssinia were rewarded by the gold medal of the society, and whose observations in that country were, for their great accuracy, of so much service during the Abyssinian war.

The survey of Palestine, a work which has been said by a distinguished German geographer to mark the commencement of a new era in geographical research, is progressing favourably, and has led to the formation of an American society for the exploration of the country east of Jordan, and of a German society for the exploration of Phœnicia. The Rev. Dr. Porter, from whose labours in Palestine everyone who has visited or takes an interest in the country has derived so much profit and pleasure, will read a paper on the lesser known parts of Eastern Palestine, which he has recently visited; and a paper on the progress of the survey has been prepared by Lieut. Conder, R.E., the officer in charge. Our own survey is, I regret to say, languishing for want of funds, whilst that of the Americans is receiving that support from the people which it deserves; the serious loss which the fund has experienced in the death of Mr. Drake, who recently succumbed to an attack of fever at Jerusalem, and who had previously devoted his best energies to the work, must be still fresh in your memories. Lieut. Gill, R.E., who accompanied Col. V. Baker last year on a tour to Meshed, and the head waters of the Atrek, has prepared an account of their journey. Some most interesting particulars of the visit of a portion of Mr. Forsyth's mission to the Great Pamir and Wakham have been kindly supplied by Col. Biddulph, R.A., from letters received from his brother, Capt. Biddulph. The success of the party has, however, been purchased by the loss of Dr. Stoliczka, who died from the effects of fatigue and exposure within a few marches of Leh. Mr. Delmar Morgan has prepared a very valuable paper on Russian travels in Central Asia in the 15th century. Mr. MacGahan, the correspondent of the *New York Herald*, whose remarkable journey across the Desert to join General Kaufmann's column when marching on Khiva astonished the Russians, has forwarded some interesting notes on the Russian expedition against Khiva.

In Australia the great geographical event of the year has been Col. Warburton's journey from Alice Springs, near Mount Stuart, on the line of overland telegraph, to Roebourne, in Nichol Bay, for which he was awarded the Patron's gold medal of the Royal Geographical Society. Such particulars of the journey as have been forwarded to me through the courtesy of the Colonial Office and of Mr. Dutton, the Agent-General for South Australia, will be communicated to you.

In America, whilst the coast and inland surveys have been progressing, Dr. Haydon, who was the first to disclose to us the strange beauties of the Yellowstone region, has been engaged in exploring a country equally wild and picturesque, the eastern half of Colorado. Other exhibitions have been doing good service in the Yellowstone country, Arizona, Oregon, and the Aleutian Islands, amongst them one sent out by Yale College, which, besides exploring new country, brought back five tons of specimens from the great fossil beds of Oregon and other places for the college museum. I cannot help thinking that in sending out these expeditions—for this is only one of a series—for the examination of the geography, geology, botany, zoology, &c., of some special district, Yale College has set an example which might well be followed by our own universities, and that Dublin, Oxford, and Cambridge might take more part than they have hitherto done in what may be called scientific exploration in the field. My old friend and fellow-traveller, Capt. Anderson, R.E., has been engaged as chief astronomer of the International Boundary Commission in running the 49th parallel through the unknown country between the Missouri and Saskatchewan, and a short account of the demarcation of the parallel and the country it passes through will be read to you. In the south, Commanders Lull and Selfridge have found practicable routes for ship canals from Greytown, by Lake Nicaragua, to Brito, on the Pacific, and by way of the Atrato, from the Gulf of Darien, to a point near Cupica, on the Pacific; the cost of the latter is estimated at twelve million pounds. In South America Prof. Orton has been extending our knowledge of the Amazon country; and I may mention the activity which the Peruvian Government is showing in promoting the exploration of the little-known districts of Peru. Mr. Hutchinson, late her Majesty's Consul at Callao, has forwarded a paper on the commercial, industrial, and natural resources of Peru, which will be found to give much interesting information on that country.

Dr. Carpenter will, I hope, give us some account of the cruise of her Majesty's ship *Challenger*, which cannot fail to interest the people of this town, from Prof. Wyville Thomson's former connection with it. Capt. Warren, R.E., whose name is so well known from his work at Jerusalem, has forwarded a valuable paper on reconnaissance in unknown countries; and Capt. Abney, R.E., will read one on a subject which he has made peculiarly his own—the application of photography to military purposes. M. Mazznoir, the secretary of the French Geographical Society, has forwarded a paper on the objects sought to be obtained by the International Congress to be held at Paris in the spring of next year.

I regret that I am not able to give any definite information on the probability of Government assistance to Arctic exploration, but I understand that the impression produced on the members of the deputation which recently had an interview with the Prime Minister on the subject was that he was not unfavourable to such assistance. Admiral Sherard Osborn has kindly forwarded a paper on routes to the north pole, and Lieut. Chermside, R.E., who accompanied Mr. Leigh Smith on a very remarkable voyage last year to Spitzbergen, will read an account of the discoveries they were enabled to make. The reports of the officers of the *Polaris* have been published, expressing contradictory opinions as to the possibility of their having been able to reach a higher latitude. As regards the general subject of Arctic exploration, there can, I think, be no doubt that that by Smith's Sound would yield the most important scientific results, and would offer great facilities for reaching the Pole itself. It should not be forgotten that all recent Polar expeditions sent out from this country have been despatched with the special object of ascertaining the fate of Sir John Franklin, and that discovery was not a principal object. When, too, we consider that in these expeditions Arctic travel was reduced to a very perfect system, that the distance from the point reached by the *Polaris* to the Pole is less than has already been performed in some of the sledge journeys, and that no life has ever been lost on a sledge journey, it is impossible to doubt that a well-organised expedition would be able to reach the Polar area. In the words of a well-known Arctic explorer, "What remains to be done is a mere fleabite to what has already been accomplished." Morton, the second mate of the *Polaris*, says, as the result of his third voyage, that he is more than ever convinced of the practicability and possibility of reaching the Pole; and if I may express my own opinion, it would be in the words attached to a picture at the last exhibition of the Academy in London, "It is to be done, and England ought to do it."

Reports.

Report on the Rainfall of the British Isles for the years 1873–74.

We extract from the report the part relating to the rainfall of the British Isles during the years 1872–73. The very exceptional character of the rainfall of 1872 was mentioned in our last report, but in accordance with a custom which has now prevailed for twelve years, it was only incidentally referred to, the details being deferred until the two years 1872 and 1873 could be published together. This course, which was originally adopted with a view to economy in printing, has in the present instance had the fortunate result of bringing together two very remarkable features of each, of which we must speak separately.

Rainfall of 1872.—Records of rainfall have been collected and discussed in our previous reports, which enable us to compare the total fall in any year from 1726 to the present time with the mean fall. One of these tables (that facing p. 286 Brit. Ass. Report 1866) contains nine long registers, extending over 140 consecutive years, but the greatest excess even at a single station was only 58 per cent. (at Oxford in 1852). In 1872 this value was largely exceeded at a number of stations, as is shown by Tables I. and II., whence it appears that at fourteen stations out of 115, or 12 per cent., it exceeded this previously unparalleled value. At thirteen the excess was greater than 60 per cent., and it reached or exceeded 70 per cent. at the following stations:—

Shropshire, Shiffnall .	Rainfall	77	per cent. above average	1860–69.
„ Shrewsbury .	„	75	„	„
„ Hengoed, Oswestry	„	70	„	„
Northumberland, Bywell .	„	77	„	„
Haddingtonshire, East Linton	„	70	„	„
Aberdeenshire, Braemar .	„	78	„	„

No similar falls have occurred since 1726, and there is no evidence of such a fall since rainfall observations were commenced, nearly two centuries ago. Full details respecting the monthly fall of rain in this very remarkable year are given in the appendix to this report, and we think it may be regarded as fortunate that so remarkable a fall has occurred at a period when, owing largely to the operation of this committee, the system of observation is in a state unprecedentedly near perfection.

The Rainfall of 1873.—If this year had stood by itself it would merely have been classed as a rather dry year, and would have soon passed into oblivion. Coming, however, immediately after such an exceptionally wet year, it has produced the unusual result of giving two consecutive years, one with twice the rainfall of the other, and in many instances with much more than twice. How rare is this occurrence may be judged from the fact that there is no case in the 140 years' table just referred to. The nearest approaches are—Chatsworth, in 1788, 19·86 inches, in 1789, 36·31, the former being 55 per cent. of the latter. A still nearer approach occurred at Cobham, in Surrey, in 1851 and 1852, when the totals were 17·38 and 34·19 inches respectively, the former being 51 per cent. of the latter. In Table II. no cases are admitted unless much more striking than the above. The districts in which these exceptional ratios occur are (as might be expected) principally those in which the excess in 1872 was greatest, but there are also a few of which the explanation is not so obvious. It is very satisfactory to feel that these two exceptional years have found in the British Isles the most nearly perfect system of observation in the world.

Your committee cannot close their report without expressing as far as words can do so the loss which they have sustained in the death of Prof. Phillips, one of the original members appointed in 1865, who, notwithstanding the numerous other demands upon his time, was always as willing as he was able to assist the committee in any of the various difficulties which the extent of their operations inevitably involve.

Preliminary Report on Dredging on the Coast of Durham and North Yorkshire.

The dredging off the coasts of Durham and North Yorkshire, provided for by a grant from the British Association last year, was carried out during the week beginning on the 13th July. A suitable vessel was engaged, and being on the whole favoured by the weather, we dredged every day until the 18th inclusive. During two days the R.A. M. Marman accompanied us. We were indebted to him for valuable assistance in naming some of our specimens, as well as for kindly undertaking to report on some sections of the work.

On two days out of the six the sea was too rough to allow of the dredges being worked very successfully, and one dredge was unfortunately lost by getting fast on hard ground while a very strong tide was running, but with these exceptions the work was carried out satisfactorily. The dredging ranged from near Tynemouth, on the north, to Scarborough, on the south, the water varying in depth from 20 to 45 fathoms, the greater portion of the time being devoted to a belt known to fishermen as the "inner fishing bank," lying from four to eight miles from the shore. One day, however, was spent at the greater distance of thirty to forty miles from shore, and another day at a distance of about seventeen miles.

Time has not allowed of anything more than safely to preserve and arrange our captures. On a future occasion we hope to give a full account of the results obtained.

NOTES

The final programme of the Oriental Congress, to be held in London next month, was settled on Tuesday; we hope to be able to say something about it next week.

M. Alluard, director of the Meteorological Observatory which is being erected on the Puy-de-Dôme, regrets that, owing to the backward state of the works, the building cannot be opened in the end of September, as was expected. It is hoped, however, that the work of the Observatory will be commenced before winter. The construction of the telegraphic line which will connect the station on the plain at Clermont with the station on the summit of the Puy-de-Dôme has been completed. The formal inauguration will take place next summer. One main cause of the delay is owing to the fabulous prices demanded by the small proprietors through whose lands the approaches to the Observatory must be made; no blame whatever for the delay can be attached to the staff of the Observatory. The Government authorities, central and local, have shown the greatest zeal in forwarding the construction of the works.

The Emperor of Austria has conferred the decoration of Knight of the Order of the Iron Crown, with a patent of hereditary nobility, on Dr. Julius von Haast, director of the Museum of Canterbury, New Zealand, in recognition of his eminent scientific merits and attainments.

Sir William Fairbairn, Bart., F.R.S., died on the 18th inst., in his eighty-fifth year, having been born at Kelso, in Scotland, in 1789. What Sir William has done to improve the manufacture of iron is well known. He was one of the founders of the British Association, and was its president in 1861. Many papers by Sir William appeared in the Philosophical Transactions, in the Reports of the British Association, and in the Transactions of the Philosophical Society of Manchester. Some of his works, however, were also published separately. Among his chief productions may be specified treatises on "Canal Navigation," on "The Strength and other Properties of Hot and Cold Blast Iron," on "The Strength of Locomotive Boilers," on "The Strength of Iron at Different Temperatures," on "The Effect of Repeated Melting upon the Strength of Cast Iron," on "The Irons of Great Britain," on "The Strength of Iron Plates and Riveted Joints," on "The Application of Iron to Building Purposes in General," on "Useful Information for Engineers," &c.

It is stated that the Crown has appointed Mr. John Ferguson, M.A., to the chair of Chemistry in Glasgow University, vacant by the retirement of Dr. Thomas Anderson.

The subscriptions announced up to Saturday last on behalf of the University of Edinburgh Buildings Extension Scheme amount to 69,017*l*. The total sum required from the public is 100,000*l*.

The Council of the Ray Society, in presenting their Thirty-first Annual Report, congratulate the members on the continued prosperity of the Society. The arrears in the issue of the annual volumes, long a cause of much inconvenience, have been at length overcome. Since the last meeting, at Bradford, two volumes, those for the years 1872 and 1873, have been distributed; a third volume, that for the year 1874, is finished, and will be issued in October. The volumes for the years 1872 and 1873, consisting of the first part of the British Annelids, by Dr. McIntosh, although containing less text and fewer illustrations than in some of the previous memoirs, have been in the matter of production equally costly. The very beautiful plates, printed in colours by lithography, required many stones for their proper development, and necessitated a corresponding outlay. The volume for the present year, on the Spongiadæ, by Dr. Bowerbank, completing the series on that subject, and, illustrated by ninety-two plates, is also a most excellent example of work both on the part of the artist and the lithographer. As the cost of this volume has been in excess of the yearly income, it is hoped that a considerable addition of subscribers will justify the money expended. The proposition alluded to in the last Report, viz., that of reducing the price of certain of the earlier works of the Society, has been much appreciated by the members, and has proved a financial success. It has been suggested that the machinery of the Society might be more largely employed in the production of Monographs on the Fauna and Flora of Great Britain; the Council therefore solicit assistance from authors who possess the requisite knowledge and who may be willing to assist in the undertaking. In conclusion, the Council, in order to obtain funds sufficient to carry out the objects of the Society, urge upon members the necessity of gaining new subscribers.

In an address recently delivered before the Dublin Obstetrical Society, Dr. Evory Kennedy discussed the development and spread of scrofula from an evolutionary point of view. This is an aspect of hereditary disease which admits of much extension; one which requires a much larger accumulation of statistics than we yet possess, and a far deeper insight into the physiological basis of pathology than we can expect for some time to come. There is one argument brought forward by Dr. Kennedy that deserves especial attention, which is, that as scrofula tends to early death, or the production of a few early dying offspring, the fact that it is not diminishing in its ravages proves