THURSDAY, JUNE 28, 1877

SOLDIERS' RATIONS

THAT Soldiers' Rations are not without influence upon a campaign no one will dispute. It is not enough to have murderous weapons and big battalions to insure conquest nowadays, and in the last two little wars in which this country engaged these were indeed of secondary importance. The Abyssinian campaign, when our troops marched nearly four hundred miles across a rugged and unknown country, has been justly termed a victory of engineering, while the Gold Coast expedition, by reason of the efficient sanitary arrangements which reduced to a minimum the deadly effects of a terrible climate, may be fitly called a doctor's war. No doubt in the case of European struggles, far more depends upon the purely military element; but if the Prussian needle-gun contributed in a great measure to the defeat of the Austrians at Sadowa, it is none the less true that the famous *Erbswurst*, or pea-sausage, of the Germans had much to do with their maintaining the siege of Paris during the long cold winter months of that capital's investment.

It is a little difficult to institute comparison between the nutritive qualities of the rations served out to soldiers in various countries. A soldier in the field, whether marching or fighting, must put forth more muscular energy than in times of peace, and according to Dr. Parkes and other authorities, it is the nitrogen in his food, more than anything else, that is necessary to the activity of the muscle, and this is required in greater quantity in proportion to the increase of work. That hard labour can be performed for some time without any increase of nitrogenous diet is true no doubt, but in this case it is at the expense of the nitrogenous constituents of other parts of the body, in the neighbourhood of the muscle, and it would be impossible for a man to continue such labour for any length of time. Whether the nitrogenous matter he assimilates is contained in meat or bread seems to be a matter of little import. An English soldier who gets a three quarters of a pound ration of meat daily is said to be no better off, as regards the nutritive character of his diet, than a German soldier, whose staple food is rye bread, and this one can well believe, looking at the constituents of the two food-stuffs. Meat from a lean animal, contains but 12·8 per cent. of nitrogenous matter, whereas samples of rye which have been analysed, have been found to contain as much actually as 15·8 of the same body. Moreover, the amount of water in a pound of meat and a pound of bread is a matter that must not be overlooked, for while in the former it amounts to 57 per cent., in the latter case it is only about 40. As, too, a loaf of bread constitutes of itself a very perfect diet, the starch and fat it contains supplying the calorifiant or heat-producing matter necessary in animal food, we may assume that troops fed upon good bread are as well off as those supplied with more costly rations. At the same time it cannot be denied that different climates and different conditions have a vast influence upon dietary, and while British soldiers require a goodly allowance of meat to sustain their energy, the Turk rarely tastes such food from one week to another. In fact, in the Moslem soldier we have the most easily satisfied of beings, so far as the commissariat is concerned. He does not even require bread, but will fight for weeks and months together upon rations of meal or bruised Indian corn, which serves him indifferently for breakfast, dinner, and supper. The Russian has rather better food, although from our point of view his fare may appear frugal enough. Two pounds of black bread and a quarter of a pound of fresh meat, or bacon in lieu thereof, with garlic, salt, and plenty of tea, seem to be the daily rations of the Czar's soldiers, though a coarse sweet bean, known in this country as the locust bean (Johannisbrod), is occasionally, also employed as food. There is no knowing what the composition of Russian bread is, but assuming it to be for the most part of rye or Indian corn, there should be little difference between the nutritive qualities of the rations of the Turks and Russians, supposing, that is, the soldiers in both cases receive pretty well as much as they can eat. There is enough nitrogenous matter to make muscle and bone, as well as sugar and starch, or non-nitrogenous bodies to supply animal heat and to support the respiratory organs. Taking milk as the most perfect food we have for our standard, which may be said to be made up of nitrogenous matter, oil, and sugar, we find that the proportion of nutritive, to heat-producing, or calorifiant, matter, is as one to two. Beans and peas come next in order to milk, the proportion here being as one to three, while in oatmeal it is as one to five, and in rye, wheat, Indian corn, &c., as one to seven or eight. Thus the Turk and the Russian being fed mainly upon rye and Indian corn derive equal benefit from their rations, although the Muscovite soldier gets additional energy, no doubt, from the small ration of meat allowed him.

The highly nutritive character of pea-flour at once points to the *raison d'être* of the pea-sausage of the scientific German soldier. This newly-invented food-stuff consists, as our readers probably know, of peamea and bacon fat, suitably seasoned, and pressed into skins and boiled. The ordinary daily ration of a German soldier is 2 lb. of rye bread and a dinner of soup, which sometimes has a piece of meat floating in it, but generally does not; this, together with a scanty stipend, which barely suffices to buy him a cup of coffee in the morning and a herring, or salted cucumber, to eke out his bread with, constitutes the whole of his allowances. In the last European war, these comestibles were replaced during some portion of the campaign by the *Erbswurst*, and there cannot be a doubt that the health of the Teuton army was improved by a regular and sufficient supply of this suitable food, while at the same time it greatly simplified the commissariat service of the invaders. Butchers, bakers, army ovens, and cooking pontoons were for a while dispensed with, and thus it was possible for corps and regiments to move, when necessary, without a great deal of impedimenta. Moreover, as we have seen, the pea-flour gave that extra nutrition which troops subject to unusual exertion, coupled with exposure to cold and frost required. To the English palate the pea-sausage had an unmistakable taste of tallow, and there is no doubt that all kinds of fat and grease were employed in its production when the supplies of bacon run short. Animal fat of some kind was, however, absolutely necessary to supply the system with heat, and combining the former in this way with pea-flour was a most happy idea. The pea-sausage might either be eaten cold in the condition in which it was issued to the soldier, or made into a sort of soup with boiling water.

And here we may mention a circumstance of especial interest to scientific men, in connection with the manufacture of this new food. The *Erbswurst* was produced in such huge quantities, that it was found to be absolutely impossible to procure a sufficient number of skins and bladders to contain the preparation. All sorts of substitutes were tried. Oiled fabric and vegetable parchment, as well as other waterproof materials were essayed in vain, for an envelope was required which was elastic and unaffected by boiling water. At last a chemist stepped in and solved the problem. He proposed the use of gelatine mixed with bichromate of potash, or in other words the process employed by photographers now-a-days in producing what are termed carbon-prints. It is well known that if a solution of gelatine and bichromate of potash is spread upon paper and exposed to light, the gelatine becomes insoluble in a very short time, and will effectually resist the action of cold or hot water to dissolve it, this principle being in fact that upon which photographic prints are produced, the portions of a surface which refuse to wash away, constituting a picture. This same mixture was used for treating the sausages. The food was pressed into proper shapes and then dipped into the bichromated gelatine solution, after which it was exposed to daylight for a couple of hours, when the gelatine formed a tough skin around it, capable of being boiled with impunity.

Turning to the British soldier we find in him the most daintily fed of all warriors, unless it was the Servian in last year's war. If we are to believe special correspondents, the rations of the Servian soldiers were almost unlimited, and furnished a striking contrast to the fare of the frugal Turks. An oka, or 2½ lbs. of brown bread, half an oka of fresh meat, together with a modicum of rice, meal, and paprika was the daily ration, the last-named comestible being employed for making soup; the *pot-au-feu*, so we were assured, was to be found simmering in camp from early morn till noon, and then only came off to make room for the coffee kettle. The Servian soldiery, too, usually had a ration of spirits called slivovitch, or plum brandy, allowed them, and yet withal they had no such powers of endurance as the maize-fed Turks. In this country a soldier's ration is three quarters of a pound of meat and one pound of bread, which is supplemented in war time by a quarter of a pound of cheese, together with cocoa or tea, sugar, &c. In the Crimea there was a standing order that hot tea should always be kept ready when practicable, so that the men might partake of it at any time, and in the Abyssinian and Ashantee campaigns the camps were never broken up of a morning before the troops had been supplied with a cup of warm coffee for breakfast. Tea and coffee exercise the same effect upon the system as wine and spirits, but their stimulative action is less marked, and our commanding officers are enjoined never to issue a ration of spirit except under extraordinary circumstances, as in the case of distressing marches, or when troops are engaged in the trenches or up at the front. And yet, as we have said, with this apparently liberal feeding, our men do not receive so much actual nourishment or nitrogenous matter as the German soldier, whose mainstay is the 2lb. loaf of black bread he receives daily. The meat, bread, sugar, &c., received by our soldiers in the Crimea yielded, we are told by the Royal Commissioners, but 23·52 oz. of nutritive principle, while Germany gives her soldiers 32·96 oz., which is still further increased when the latter are fed on such highly nitrogenous diet as the pea-sausage. The Turks, poor as their food may seem to us, probably derive as much nutriment from it as English troops from their bread, meat, and cocoa, for weight for weight, the Turkish rations contain more nitrogenous matter. If, too, their meal is what is termed "whole flour" it will, since it includes the husk, contain more nitrogen still, and, like oatmeal, be one of the most generous foods known. Our Scotch troops, we fancy, would be little the worse if fed solely on porridge for a time. The reader may remember Lord Elibank's retort on Dr. Johnson's definition of oats as the food of horses in England and of men in Scotland: "Yes," said he, "and where else will you find such horses and such men?" A growing soldier, hard at work all day at gun-drill, or other laborious work, does not buy extra meat when he is hungry, but foregoes his beer at the canteen for another pound loaf, thus approaching his diet very nearly to that of the German warrior, whom we have shown lives almost entirely on bread and enjoys the most nutritive fare. At the same time it is necessary to bear in mind that the conditions under which a man lives must guide the nature of his food. A man inhabiting a cold climate such as ours, requires more animal food than would be the case if he lived in a country nearer the equator, and British troops, we fear, would loose much of their energy if fed altogether on farinaceous food. But as we have striven to show, it is not always a so-called liberal diet which affords the soldier the greatest quantity of nutriment. H. BADEN PRITCHARD

GEIKIE'S "PHYSICAL GEOGRAPHY"

Elementary Lessons in Physical Geography. By Archibald Geikie, LL.D., F.R.S., Murchison Professor of Geology and Mineralogy in the University of Edinburgh, and Director of the Geological Survey of Scotland. (London: Macmillan and Co., 1877.)

AS our knowledge of natural phenomena widens and our insight into the character and mode of operation of the forces which give rise to these phenomena becomes more profound, we are called upon from time to time to take a new survey of the fields of inquiry and to reconsider the principles on which the useful, but necessarily more or less arbitrary, classification of the natural history sciences is made to depend. To instance a notable example, the time-honoured division of the "three kingdoms in nature" has now, by almost universal consent, been abandoned in favour of a more logical grouping of the objects of natural history science depending on the presence or absence in them of the principle of life, and hence has arisen the term biology to include botany and zoology, while mineralogy, released from an unnatural bond, seeks and finds new alliances with those branches of knowledge, crystallography, chemistry, and petrography, with which it has so many and such intimate relations. Etymological purists have indeed cavilled at the term "biology," and the opponents of change have disputed its *raison d'être*, but it is impossible to deny that its invention was the natural consequence of the growth of juster views concerning the relations of living beings to one another, or that, on account of its fitness, it bids fair to survive all hostile criticism.

Now in the same way that the development of our knowledge of the lowest forms of life has led to the breaking down of the unnatural barriers between the animal and vegetable kingdoms, and the union of all the anatomical, physiological, systematic, and ætiological branches of our knowledge of living beings into the federal republic of biology, so the growth and establishment of a juster geological philosophy has greatly modified, and indeed almost revolutionised, our conception and treatment of certain branches of geographical science.

For more than half a century the principle which demands that the geologist shall interpret the past history of the globe by means of a constant reference to the operations now going on upon its surface, has been steadily gaining ground; and this postulate may now be said to have taken its place as the very cornerstone in all geological reasoning. But if geology has thus to own her dependence on geographical knowledge, she has more than requited her obligations by the new vitality which she has infused into her sister science. It is not too much to assert that the growing conviction of the necessity for a more systematic, a more searching, and a more accurate investigation of the phenomena of the globe and of the forces by which they are produced—a conviction which has prompted the despatch of expeditions for carrying out carefully organised researches both on sea and land—has been to a very great extent created and fostered by the revelations of glaring imperfections in our knowledge of the earth's existing economy which are continually being made by geology.

The work before us is an example of the treatment of geographical questions from the point of view of a geologist, and we are not surprised to find that its author is evidently strongly actuated by the conviction of the necessity for a broader and more vivid presentation of the action and reaction upon one another of the various forces operating upon the surface of the globe, than is usually found in works on physical geography, in order to convey a just idea of the character and significance of the features which it presents. Thus, in the introductory chapter, after referring to that complex interplay of agencies by which the fluid envelopes of the globe are maintained in constant circulation, and the elements of its solid crust made to pass through ever-varying cycles of change—a series of phenomena which has suggested to the profounder thinkers of all ages an analogy between our planet and a living being—the author goes on to say:—

"Now this life of the earth is the central thought which runs through all that branch of science termed physical geography. The word geography, as ordinarily used, means a description of the surface of the earth, including its natural subdivisions, such as continents and oceans, together with its artificial or political sub-divisions, such as countries and kingdoms. But physical geography is not a mere description of the parts of the earth. It takes little heed of the political boundaries except in so far as they mark the limits of different races of men. Nor does it confine itself to a mere enumeration of the different features of the surface. It tries to gather together what is known regarding the earth as a heavenly body, its constitution, and probable history. In describing the parts of the earth—air, land, and sea—it ever seeks to place them before our minds as to make us realise not only what they are in themselves, but how they affect each other, and what part each plays in the general system of our globe. Thus physical geography endeavours to present a vivid picture of the mechanism of that wonderfully complex and harmonious world in which we live."

In that easy and graceful style, of which he possesses so perfect a mastery, the author proceeds in subsequent chapters to give a sketch of those vast fields of knowledge which are opened up to us by this method of looking at the phenomena of the globe. The book is exactly what it professes to be—a series of elementary lessons; but, while it may be read with profit and delight by any fairly-taught schoolboy, it will not be found wanting in instruction and suggestiveness for more advanced students. On some questions, as for example that of the nature and causes of the great movements of the atmosphere, the author has been particularly successful in embodying within a very small compass a mass of information which the student could otherwise gain only by the perusal of a number of special treatises. To teachers of elementary science who desire a model on which to frame their lessons for beginners, so as to secure their attention and interest and to arouse the enthusiasm of such among them as are capable of that sentiment, we very heartily commend this admirable little book.

The author points out in a note that the subject of physical geography, as here treated of, is conterminous with that division of science for which the name of physiography has been suggested. The advances made in recent years in the study of physical astronomy and the relations which have been established between celestial and terrestrial objects by the development of spectrum analysis and the study of meteorites, taken in connection with that strongly-felt necessity for a deeper insight into the mode of operation of the forces operating upon the surface of the globe, both from within and without, which geological research has awakened, have independently suggested to many thinkers the desirability of permitting certain portions of natural knowledge to crystallise around a new centre. The importance of this new science thus growing up on the confines of geography, geology, astronomy, and biology, and linking them all together, a science the study of which would form the most fitting preparation for the detailed pursuit of all and each of the natural sciences, was long ago pointed out by Prof. Huxley; and in a course of lectures delivered in 1870 he sought to illustrate the objects and methods of this latest-born member of the family of the natural sciences. In that most excellent of geological text-books, Prof. Dana's "Manual of Geology," the term "physiography" is also employed, in the same sense as advocated by Prof. Huxley. Nor is the use of the term confined to English writers, for in several of the best German manuals of geology, such as Dr. Hermann Credner's "Elemente der Geologie" and Dr. F. von Hochstetter's "Die Erde nach ihrer Zusammensetzung, ihrem Bau, und ihrer Bildung," the necessity of this term physiography is admitted and its use justified. Like the term "biology," that of "physiography" may not improbably meet with some opposition on its first introduction, but as the importance and connection of the branches of knowledge which it embraces become more widely appreciated, the necessity and convenience of the name will doubtless make themselves very generally felt. In conclusion, we cannot part from the little book which has prompted these remarks without taking the opportunity of congratulating the author on his success in presenting to the public, in a form at once compendious and popular, the outlines of this very important branch of science. J. W. J.

THE LABORATORY GUIDE

A Manual of Practical Chemistry for Colleges and Schools. Specially Arranged for Agricultural Students. By Arthur Herbert Church, M.A., Professor of Chemistry in the Agricultural College, Cirencester. Fourth Edition, revised. (London: John Van Voorst, 1877.)

THE fact that Prof. Church's "Laboratory Guide" has reached a fourth edition is a proof that the work has been found useful by that class of students for whom it is specially arranged. Notwithstanding this fact we cannot regard the book as occupying other than a second-rate position in the literature of applied chemistry. The aim of the "Guide" is (1) to place before the student a series of lessons in chemical manipulation in working through which he shall obtain a practical knowledge of "some of the chief truths learnt during the course of lectures on inorganic or mineral chemistry;" (2) to instruct the student in qualitative analysis with especial reference to the analysis of agricultural products; (3) to lay before the more advanced student a number of processes for the quantitative analysis of agricultural substances, food stuffs, manures, &c. The first part of the work comprises a number of fairly well chosen examples in chemical manipulation, preparation of gases, and examination of solid substances. What we should most object to in this portion of the "Guide" is want of method. A few blowpipe experiments are introduced here and there, followed, perhaps, by a short description of one or two rough experiments illustrative of the manufacture of superphosphates; these are succeeded by desultory tests for sugar in milk, by casual semi-quantitative experiments on bread, and so on. To a student without any knowledge of chemistry such a course as that sketched in the first part of the "Guide" may be of use, although we think more care would require to be shown in the selection of experiments; but the book assumes that the student accompanies his practical work by attendance on lectures; surely then the practical course ought, from its very commencement, to be systematic and progressive. The directions given in each lesson are, as a rule, too meagre; without the constant superintendence of a teacher we doubt whether the beginner in practical work could make much progress. In some cases the directions are so vague and inexact as to be positively misleading: witness the method for detecting alum in bread (p. 43). Part II. treating of qualitative analysis has the same failings as Part I.; it is not exact and definite. The author, in his introduction, especially announces that the work is limited in its aim, so that we cannot find fault with him for not including tests for all the metals; but so far as it goes the information given, and the system of teaching pursued, should have been definite, condensed, and such as would train the student in habits of accuracy. No doubt the reactions detailed are true so far as they go; the schemes of analysis are tolerably good, yet there is about it all a slipshod appearance which stamps the work with an unsatisfactory character.

The processes of quantitative analysis are chiefly such as are required in the examination of agricultural products, and substances used in manufacturing manures, of a few leading food stuffs, of soils, and of waters. As the author has not wished to produce a large work, he has limited himself to a description of methods of analysis "intended only for the particular case mentioned;" these processes "may fail if . . . . other substances be present than those here supposed." We cannot help thinking that this is exactly what he ought not to have done; if the book is to be a guide to the student, if it does not pretend to the place of an encyclopædic reference book, then processes of *general* applicability, should have been selected, processes which would illustrate the application of the general principles of analysis, not processes which the student is to learn by rote, and which he will therefore come to regard in much the same light as that in which the cook views her book of receipts. Many of the processes, regarded simply as prescriptions, are faulty or very meagre. Who would apply the volumetric Uranium method for determining phosphates in the manner described on pp. 157, 158? Aided only by the description of the volumetric method for determining chlorine given on pp. 159, 160, who could ever hope to perform an exact estimation of that element? From what is said on p. 150 one would suppose that "reduced phosphates" can be readily determined with something like accuracy. Th report of the British Association Committee has shown that no method for even approximately determining these phosphates has as yet been introduced.

The processes for the analysis of milk, cheese, and butter are extremely meagre. Now that we are possessed of really good and reliable methods for analysing these food stuffs, the introduction into a manual of vague and sketchy methods is almost worse than the omission of all methods, whether good or bad.

One point there is in which Prof. Church deserves all praise, namely, the employment of a systematic nomenclature. The system adopted is that first employed in the works of Roscoe, and of Harcourt and Madan, and now adopted in the *Journal* of the Chemical Society, in Watts's *Dictionary*, and in most of the modern treatises. This system, although not slavishly bound down by rule—although it allows one to say *sulphate of zinc* as well as *zincic sulphate*—is founded on certain definite ideas, and has, at the same time, shown itself capable of expansion with the needs of an increasing science.

The system is, moreover, nearly identical with that employed by the German chemists. Prof. Church has done well in making use of it.

OUR BOOK SHELF

Researches on the Glacial Period. By P. Kropotkin. First fascicule. 827 pages in 8vo. With Maps and Woodcuts in a separate brochure. (*Memoirs* of the Russian Geographical Society, vol. vii., 1876.)

THE book consists of two parts. The first is a detailed account of a journey in Finland and a short visit to Sweden, both made in 1871 under the auspices of the Russian Geographical Society, for the special purpose of studying the glacial formations and the *ösar* (eskers or kames). The second part is an inquiry into the meaning and value of various evidences of the glacial period—the striation of rocks, the forms of rocks and mountains, the boulders, the loose deposits, and the moraines and *ösar*. Out of the seven chapters into which this part is divided only the three first (sketch of the development of the glacial theory, striation, and forms of mountains) appear in this fascicule, and the two last (loose deposits and their classification, moraines, and *ösar*) are summarised at length in an Appendix.

The first fascicule is illustrated by a hypsometric map of Finland (southern half) with all known *ösar* shown upon it; by a map of the most interesting, esker Pungaharju, five miles long; by some other maps and sections of less importance; by a section on a large scale of the loose deposits along the Tavastehus-Helsingfors Railway, and by ninety woodcuts, a large part of which are sections of *ösar*.

The main conclusions as to the glaciation of Finland are in accordance with those arrived at by Messrs. Erdmann, Wiik, Helmersen, and Schmidt, viz., that this low table-land, continuous along its north-western and southern borders with two low and flat border-ridges, was covered with an immense ice-sheet which, creeping from Scandinavia, crossed the Gulf of Bothnia, traversed Southern Finland in a direction south by east, crossed the Gulf of Finland and crept further on in the Baltic provinces. The numberless striæ, the positions and directions of which exclude any suspicion of their having been traced by floating ice, the striation on the islands of the shallow gulfs, together with that of the Onega basin, the Neva valley, and the Baltic provinces, the uninterrupted sheet of till, *i.e.*, of a true unstratified and unwashed morainic deposit covering Finland, the numberless moraines parallel to the glacial striæ, and hundreds of other evidences, settle the existence of such an ice-sheet beyond any doubt. As to traces of marine formations, there are none above a level of about 100 to 120 feet; only local lacustrine deposits cover the till above this level.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.]

Indian Rainfall and Sun-spots

I HAVE observed no notice in NATURE[1] of an important discussion which took place a month ago at one of the Royal Society's meetings on Dr. W. W. Hunter's report on the cycle of rainfall in India, and its coincidence with the periods of eleven years disclosed by sun-spot observations. As one interested in solar research I have carefully considered that report, and I think the author has made out a case within the limits which he assigns to himself. The application of the mathematical law of errors has not altered this opinion in my mind, and from a consideration of the whole subject I have been led to the following conclusions:—In the first place I would remark that in certain meteorological elements, of which the rainfall throughout the world is probably one, and the barometer *in these latitudes* is another, oscillations which we regard as non-periodic, are very large compared with periodic variations. The consequence will be that in dealing with a series of barometric observations in these latitudes, the mean difference of individual observations from the mean of the whole series, or in other words, the mean irregularity, will not be materially modified by the introduction of the comparatively small semi-diurnal variation. But this is no argument against the existence of such a variation, nor is the fact that at Madras the mean rainfall irregularity is not *greatly* reduced by the introduction of an eleven-yearly cycle any argument against the existence of such a cycle. As a matter of fact, this mean irregularity *is reduced, although perhaps not very markedly*, by the introduction of this cycle. The true test of a physical cycle is its repetition, and, since in the present important aspect of this question we cannot, perhaps, calmly wait for other sixty-four years' observations before venturing a conclusion, let us now endeavour to break these sixty-four years up into periods, and see whether we obtain any traces of physical persistence from this method. Grouping, as Dr. Hunter has done, the sixty-four years' Madras rainfall into series of eleven years, beginning with the first in 1813, we obtain the following table:—

Years employed.	Year of Series.										
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
A. 1813–23 ...	45·11	32·41	56·00	41·16	63·56	76·25	36·33	70·01	47·13	59·61	26·62
B. 1824–34 ...	33·72	56·05	60·73	88·41	37·89	36·87	32·43	44·35	18·45	37·11	39·00
C. 1835–45 ...	41·47	44·76	49·26	52·33	53·07	58·65	58·32	36·48	50·28	65·36	38·05
D. 1846–56 ...	79·81	80·99	54·76	39·81	36·88	64·32	72·69	35·82	43·20	32·32	46·99
E. 1857–67 ...	52·95	48·50	55·14	27·64	37·19	38·18	54·61	47·23	41·64	51·39	24·37
F. 1868, end.	41·43	32·31	74·10	56·35	73·67	51·83	62·90	37·12	21·49		
Whole period.	49·1	49·2	58·3	50·9	50·4	54·4	52·9	45·2	37·0	49·2	35·0

In this table 3, 4, 5, 6, 7 embrace the maximum rainfall group, and 8, 9, 10, 11 the minimum rainfall group, and the sun-spot maximum occurs generally about the beginning of 3, and the sun-spot minimum a little before 11.

We have, therefore, taking the means of the five maximum rainfall years a result = 53·4 for the whole six series, and also, taking the means of the four minimum rainfall years, a result of 41·6 for the whole six series.

But we can obtain similar results for each individual series as under:—

	Max. Group.		Min. Group.
Series A	... 54·7	...	50·8
,, B	... 51·3	...	34·7
,, C	... 54·3	...	47·5
,, D	... 53·7	...	39·6
,, E	... 42·6	...	41·2
,, F	63·8	...	29·3 (incomplete.)

We have thus considerable evidence of repetition. In connection with this it will be interesting to see if there is any other physical difference indicated between years of maximum and minimum spots besides mere difference of rainfall. Now a very interesting additional peculiarity has been indicated by General Strachey, who has observed that the conception of a cycle of eleven years introduces a decidedly diminished mean cyclical deviation for the minimum period. General Strachey has, no doubt, likewise remarked that this is not chiefly due to those particular years that are nearest the sun-spot minimum. I do not, however, see that we have any right in tracing a connection between solar epochs and rainfall values to insist that the minimum of the one shall correspond absolutely with the minimum of the other, and the maximum of the one with the maximum of the other. In conclusion, the fact that the introduction of a solar cycle diminishes considerably the deviation for minimum years is one of very great interest, since it is these very years that have become so practically important. I trust, therefore, that further attention will be devoted to this very interesting inquiry.

BALFOUR STEWART

[1] See abstract of Gen. Strachey's paper on another page.

Natural History Museums

I AM sure that many readers of NATURE will heartily thank Prof. Boyd Dawkins for his valuable articles just published in your journal on the need of establishing natural history museums in the principal towns of our country. The ideas set forth cannot fail to be reciprocated by a largely increasing number of students who, like myself, are suffering under the disadvantages of not having local museums for reference and in which to compare specimens and examine the various natural history objects which I wish to study. In addition to a museum, I think such buildings should contain lecture-rooms specially fitted up for scientific lectures, as the value of able discourses is frequently lost for want of clearness in illustration.

The professor cannot over-estimate the value of museums, as every lover of natural history cannot be a collector; but every one in full possession of his faculties can observe so far as he has the power of seeing, and if he cannot examine the wide field of nature for facts he will at least examine the proofs of them in the museums, if at hand.

A few personal observations may serve to show the difficulties under which the so-called working classes have to labour in the pursuit of knowledge.

Some years ago I began to study the works of Sir C. Lyell and other authors on geology, and while so engaged I many times travelled eighteen miles after a hard day's work to compare specimens in the old museum, St. Peter's Street, Manchester. I had tabular views of the characteristic British fossils at hand, but as perfect specimens only are figured, I experienced a doubt and uncertainty pretty nearly in everything I wanted to compare, while in the museum I could find the actual specimen sought after with which to correlate those of my own. The flash of satisfaction experienced by a collector on comparing his objects with those in a well-arranged museum is indeed very great, and there are few things more likely to stir him up to renewed efforts. But the interest of museums is not confined to the collectors of natural history objects; it extends to every man who reads and cares to master the objects about which he reads. In this way his knowledge of things becomes real and he expresses himself with confidence, and in many cases has decided while others are thinking. To show further the need of museums I may state a fact perhaps not generally known, that in one place in the north of England a large number of science students have formed themselves into an itinerant society moving from place to place to suit the convenience of the various members who reside apart. The meetings are generally held at a respectable inn on Sunday evenings, at which papers are read by the more ambitious members, and any interesting objects named, which some of the party never fail to bring up, and their habitat declared.

If the corporate bodies or the educational department of the State would only undertake to provide museums in the principal towns of our country I feel sure that the cry of continental superiority would soon vanish. At home we have the materials out of which the philosopher and the artisan can spin the fibre of future greatness by rightly directing the forces of nature, but the isolated fragments want collecting and receptacles providing in which to store them. Many lives like that of the Banff naturalist could be written if only known, and Prof. Dawkins could not have fixed on a centre of operation more favourable from which to begin than that of Oldham. Men more selfishly removed above praise, working for science for its own sake, he cannot find, and it is a pity that they have not a common repository in which to store their invaluable collections beyond their own full cabinets. I hope the professor's articles will be a means of calling attention to the desirability of establishing museums for the better diffusion of scientific knowledge.

I write from the point of view obtained by my own experience as a working man who has done his best to educate himself.

WM. WATTS

Corporation Waterworks, Oldham, June 16

Koenig's Tuning Forks

ON vient d'attaquer en Angleterre l'exactitude du diapason officiel français. Mr. Alexander J. Ellis ayant trouvé que les notes d'un tonomètre, composé de 65 anches d'harmonium et construit par Mr. Appunn, ne s'accordaient pas avec ce diapason, a cru devoir déclarer dans un mémoire publié par le *Journal of the Society of Arts* (25 Mai, 1877), et dans votre journal (31 Mai, 1877), que le La_3 normal français donnait non pas 870 vibrations simples, comme on l'avait cru jusqu'à présent, mais bien 878 vibrations simples.

Mr. Ellis ayant constaté de plus que les diapasons de ma construction s'accordaient parfaitement avec le La_3 français, n'a pas hésité à affirmer que tous ces diapasons, y compris ceux de mon grand tonomètre, qu'il n'a probablement jamais vus, et en tout cas jamais pu examiner, étaient nécessairement inexacts. N'ayant pas à ma disposition l'instrument dont s'est servi Mr. Ellis, j'avoue que je me serais trouvé assez embarrassé pour dire immédiatement, par où pêche cet instrument au point d'avoir donné entre les mains de Mr. Ellis des résultats si extraordinaires; heureusement je me suis rappelé une lettre de M. Helmholtz à Mr. Appunn et publiée par ce dernier lui-même dans une brochure sur les théories acoustiques de M. Helmholtz; cette lettre concerne justement un instrument de même nature du même constructeur et explique suffisamment les surprenantes découvertes de Mr. Ellis. "J'ai examiné à plusieurs reprises votre tonomètre," écrit M. Helmholtz à Mr. Appunn, "et je suis étonné de la constance de ses indications. Je n'aurais pas cru que les anches pussent donner des sons aussi constants que ceux que donne l'appareil, grace à votre méthode pour régler le vent. L'instrument varie un peu, il est vrai, avec la température, comme feraient aussi des diapasons; on ne peut donc s'en servir pour la détermination des nombres absolus de vibrations que lorsqu'on peut travailler dans une pièce qui n'est pas chauffée par un poêle. J'ai compté les battements à l'aide d'un chronomètre astronomique, et je crois que votre pendule à secondes a été légèrement inexact, car, si les nombres de battements s'accordent très bien entre eux, le nombre absolu en a été non pas de 240, mais de 237 à la minute. La température, qui était assez basse pendant mes expériences, a pu y être pour quelque chose, mais on peut éliminer cette influence en comptant jusqu'au bout les battements d'une tierce majeure, ce qui m'a pris un quart d'heure. J'ai trouvé ainsi pour mon diapason de Paris 435·01 vibrations, ce qui l'accorde à $\frac{1}{40,000}$ pris avec le nombre officiel de 435·00 vibrations."

Cette lettre prouve que le nombre entier des battements de l'octave du tonomètre essayé par M. Helmholtz était de $\frac{237}{60}\cdot 64 = 252\cdot 8$, et sa note fondamentale de 505·6 vibrations simples au lieu de 512 vibrations simples. En comparant cette note de 505·6 vibrations simples avec un diapason donnant réellement 512 vibrations simples, Mr. Ellis eût trouvé ce dernier de 6·4 vibrations simples plus aigu, et l'eût sans doute considéré comme donnant 518·4 vibrations simples. Or il a trouvé 516·7 seulement pour mes diapasons de 512 vibrations simples avec le tonomètre dont il s'est servi; on voit donc que la note fondamentale de ce dernier était déjà plus exacte que celle du tonomètre examiné par M. Helmholtz puisqu'elle donnait 507·3 vibrations simples mais qu'elle restait encore assez loin de la véritable valeur.

Le fait que M. Helmholtz a pu trouver le nombre de vibrations exact du diapason officiel français avec un instrument de cette nature (et même encore moins parfait que celui dont s'est servi Mr. Ellis), en déterminant d'abord la correction de cet instrument, montre à l'evidence que Mr. Ellis a négligé de déterminer la correction du sien; il s'est donc beaucoup trop hâté de déclarer que ces petits tonomètres à anches d'harmonium sont les plus parfaits et les plus exacts qui existent, et de contester si légèrement les résultats obtenus par les Lissajous, les Despretz, les Helmholtz, les Mayer, etc., etc.

RUDOLPH KOENIG

Paris, le 5 Juin

Antiquity of Man

MR. SKERTCHLY is absolute that I am mistaken; to me it appears that he has missed the point of my letter, and misinterpreted my views. His important discoveries of flint implements in early glacial beds are, I think, strongly corroborative of the opinions I expressed in my paper on the "Drift of Devon and Cornwall" (*Quar. Journ. Geol. Soc.*, vol. xxii. p. 88), and in that on the "Geological Age of the Deposits containing Flint Implements at Hoxne" (*Quar. Journ. Science*, July, 1876); but I willingly admit that in the present stage of the inquiry Mr. James Geikie has as much right to claim that they support his theory, and I agree with the latter that it is premature to discuss the relation of man to the glacial period, before we have settled what was the succession of events that occurred at tha time.

Mr. Geikie contends that there were two or more glacial periods with inter-glacial warm or mild ones; I, that there was only one glacial period and that the disappearance of palæolithic man from Northern Europe was principally due to the submersion of the greater part of the land beneath the water of an immense freshwater lake or sea, at or a little before the culmination of the ice age. If Mr. Geikie's views should be ultimately accepted, the term "inter-glacial" will be most appropriate; but should, as I hope and believe, mine be proved to be nearer the truth, I should prefer to use the term "pre-diluvial" instead of "pre-glacial," as heretofore, to express the age of palæolithic man.

THOMAS BELT

The Cedars, Ealing, June 22

WILL you kindly allow me to correct an apparent breach of official etiquette and act of discourtesy in my last week's letter? I should have said that only two geologists prominently interested in the question at issue had seen my evidence; for, of course, Mr. H. W. Bristow, F.R.S., Director of the Geological Survey of England and Wales, has been kept fully *en rapport* with my work, and has several times visited me at Brandon. I am anxious that no statement of mine should appear to slight so eminent a geologist and so considerate a friend.

Brandon SYDNEY B. J. SKERTCHLY

Colour-Sense in Birds—Blue and Yellow Crocuses

UNLESS your readers are quite tired of the subject, may I add a fact which will be subversive of a good deal that has been written about yellow crocuses and sparrows. I dislike yellow crocuses, and four seasons since planted some hundreds of blue and white in the garden underneath my windows. For two seasons they flowered in beautiful profusion. In 1876 the sparrows for the first time destroyed these flowers completely. I allowed the roots to remain for another year—viz., 1877—but they suffered the same usage, hardly a single flower being left uninjured. So complete was their destruction that I have had the roots dug up.

I regard the proceeding as an imitative one; blue and white crocuses, not being common in the vicinity, were new to the sparrows, and until one more experimental than the rest attacked them they were safe.

A similar result will occur with domestic pigeons; if reared exclusively with small grain, as wheat and barley, they will starve before eating beans. But where they are thus hungry, put a bean-eating pigeon amongst them, and the habit is immediately propagated.

I have seen fowls refuse maize at first, but on seeing others eat it, they follow suit, and become excessively fond of it.

W. B. TEGETMEIER

Purple Verbenas

HAVING now read for the first time the letters in NATURE regarding the preference that sparrows show for the yellow crocus, it might perhaps help to elucidate the problem were it known that the choice of colour is not only confined to birds, as a few years ago our garden was infested by rabbits and there was a row of eight beds planted in turn, with white, red, and purple verbenas. The flowers of the red and white were eaten close off, whilst those of the purple were never touched. This happened three years running, since which, the garden, being protected by wire netting, has remained undamaged.

A. M. DARBY

Japanese Mirrors

YOUR correspondents, Messrs. Atkinson, Highley, and Darbishire, have referred to several conjectures and experiments respecting the curious Japanese mirrors and the patterns they reflect. None of these gentlemen have, however, referred to the suggestion offered by Sir David Brewster in the *Philosophical Magazine* for December, 1832. In this paper Sir David drew attention to some similar phenomena in the light reflected from the surfaces of burnished buttons of metal, arguing that in the mirrors (of which at that time he apparently had seen no actual specimen) there were slight actual inequalities of surface, artificially produced, but concealed from observation by their slightness of depth and by the brightness of the polish. This, of course, may be independent of the particular figures raised in relief on the back, as in the case cited by Mr. Darbishire; and so thought Sir David, for he added:—

"Like all other conjurers, the artist has contrived to make the observer deceive himself. The stamped figures on the back are used for this purpose. The spectrum in the luminous area *is not an image of the figures on the back.* The figures are a copy of the picture which the artist *has drawn on the face of the mirror*, and so concealed by polishing that it is invisible in ordinary lights, and can be brought out only in the sun's rays."

I trust Mr. Atkinson may be able to learn in Japan the real process of manufacture of these curious toys. Meanwhile are there not specimens in many of our museums that would repay examination? Were there not some amongst last year's exhibits at the Loan Collection of Scientific Apparatus?

SILVANUS P. THOMPSON

University College, Bristol, June 25

NOTE ON THE ELECTRICAL DISTURBANCE WHICH ACCOMPANIES THE EXCITATION OF THE STIGMA OF MIMULUS LUTEUS

MANY years ago my attention was drawn to the excito-contractility exhibited by the lipped stigma of *Mimulus luteus*, the structure of which I then gave an account of in the *Proceedings* of the Edinburgh Botanical Society. In connection with my recent investigation of the excitatory variation in *Dionæa* I have, during the last few weeks, in co-operation with Mr. Page, made experiments for the purpose of ascertaining whether in this organ, as in the leaf of *Dionæa*, the change of form provoked by mechanical stimulation is accompanied by a similar electrical disturbance.

Mimulus luteus is a favourite window plant on account of its showy flowers and the facility with which it can be cultivated. The mechanism of the contraction of the stigma can be best studied in the inferior of the two lobes, of similar size and form, of which the organ consists. In the unexcited state, when the flower is in full bloom, this lobe is curled outwards. The curling outwards is due, as I long ago observed, to the turgidity of the layer of loosely connected conducting cells, ending in papillæ, which constitute the stigmatic surface. So long as this tissue is turgid the elastic lamina by which it is backed is prevented from straightening itself, so that the whole lobe forms a scroll of which the axis is transverse. The effect of touching any part of the lobe, and particularly the papillary surface, is to diminish the turgidity of the tissue, as the result of which the organ slowly expands so as to face and ultimately meet its fellow.

The excitatory change of form which I have described is, as in the case of *Dionæa*, associated with an electrical disturbance of which the following are the most important features:—(1) The sign of the variation is the same as in *Dionæa*, the excited structure becomes negative to the rest of the plant. (2) The extent of variation is somewhat less than in *Dionæa*, the electromotive force developed between the stigma and style being usually about 25-thousandths of a Daniell, whereas in *Dionæa* the variation may amount to from 40- to 50-thousandths. (3) The variation is of relatively long duration; it reaches its maximum at the ordinary temperature of summer, about five seconds after excitation. It subsides at first rapidly, then very gradually, so that the effect may not have entirely passed off until two or three minutes have elapsed.

As in *Dionæa*, the period of electrical disturbance is shortened by increase of temperature. Thus in five stigmas in which the period was measured at 20° C. (68° Fahr.) and at 37° C. (98° Fahr.), the mean duration of the interval of time between the commencement of the electrical disturbance and the moment at which it began to subside was 6·2 sec. at the higher temperature, and 3 sec. at the lower.

In general, the stigma, when in the unexcited state, is positive to the style. As, however, it can be shown that other factors, not concerned in the excitatory process, are operative in the production of this result, not much importance is to be attached to it.

I send this short note in order that physiologists interested in the subject may be able to repeat the observations during the present season.

University College, June 27 J. BURDON-SANDERSON

TAUNTON COLLEGE SCHOOL

THE circumstances alluded to last week, under which the Taunton College School is threatening to collapse, and is in immediate danger of losing the head-master who has made it what it is, are interesting on public grounds to the advocates of scientific instruction, as well as to the general educationalist. In a pamphlet published in 1865, and containing letters from Dr. Daubeny, Prof. Phillips, and Dr. Acland, Mr. Tuckwell was, we believe, the first English schoolmaster to assert publicly the claims of science to an honoured place in the curriculum of all first-class schools; and his evidence before Lord Taunton's Commission, his papers read to the British Association in 1869 and 1871, and his communications to the Royal Science Commission, show how diligently he has for twelve years past been working out in his school at Taunton the many practical problems which beset the introduction of a new subject into an ancient, established, jealous system. The school has thriven in his hands, risen rapidly in numbers, and gained the highest public distinctions at the Universities, the India Civil Service, Cooper's Hill, and Woolwich; and though the short-sighted economy of his governing body left him for years without a science master or a laboratory, and refused him a museum, botanical garden, and science class-rooms, he has overcome all these difficulties by patience, by the munificence of friends, and by pecuniary sacrifices; and at this moment many distinguished scientific visitors are glad to testify to the completeness of a system which passes the whole school through a course of physics and chemistry, and includes physical geography, botany, and meteorology in its more special training. In 1875 the number of boys had risen to 120, but the thrift of the governing body kept down the number of the masters. The typical proportion of assistant-masters to boys in modern schools of this size is one in sixteen; the Taunton masters were only one in twenty-seven. The school could not continue to succeed under this policy; the masters were unequal to the work; the number of boys fell off until a visitation of fever brought them below the paying point, and the school, already heavily in debt, was on the point of being closed. The panic-stricken officials laid the blame upon the head-master; his theology and politics were pronounced suspect; his unpopularity had caused the falling numbers; and when his friends came forward liberally with money and promises of money the governing body took the money, but upon condition that the head-master should leave at Christmas. Against this parents and old pupils are indignantly remonstrating; both have sent to Mr. Tuckwell public addresses of sympathy and confidence; the parents forwarding also a strong protest to the president of the governing body, and in many cases threatening to remove their sons if Mr. Tuckwell goes. So far, however, the custodians of the school's interests show no sign of yielding; it seems certain that the head-master will be turned out, and more than probable that the school may, after all, collapse.

There are two points in this struggle between philistinism and culture on which we should like to dwell, in the interests both of general and of scientific education. The first is the mischief being worked in the less important first-class schools by the constitution and habits of their governing bodies. These were the pet institutions of the Endowed Schools' Commission. They were to include the educated gentleman of the county and the representative tradesman of the town: the first, rich in recollections of Eton and of Christ Church, was to initiate, develop, control; to support and instruct the head-master; and to keep his *bourgeois* brother straight; while that second-rate but docile coadjutor was to back the enlightenment of his superior, and to reconcile while he typified the democratic feeling so essential, it was thought, to the local popularity of a school. Charming in theory, it was in fact the weak point in the Commissioners' scheme. The feet on which their image had to stand were of iron mixed with miry clay; the two refused to coalesce, and the clay came uppermost. The gentlemen make admirable governors, but they are in London, in Scotland, on the Continent, at Quarter Sessions; and the local men, who are always on the spot, become virtually the governing body. They too frequently know nothing of education. They cannot understand a head-master's ideas and aims; they in too many cases govern the school as if it were a workhouse, and treat the head-master as they habitually treat the master of their union. The world has not forgotten Felsted Grammar School; and the committee of head-masters could tell us of many other cases, less notorious, but not less galling and mischievous. No first-class school can thrive unless its governing body is composed of gentlemen, who understand, as Mr. Walter said the other day at Wellington College, that their first duty is not to interfere with the head-master.

The second point is one which we have often urged before: the opposition offered by many of the clergy to the *Culturkampf*. Of course there are notable exceptions to this incrimination; but the *Viri Obscuri* of Revellius, and the clerical bigots who combined to oppose the new learning of Colet, Erasmus, and More, would recognise their legitimate posterity in those of the present day, who, themselves uneducated even according to the narrow standard of the past, join in denouncing science and unsectarianism as the irremissible sins of a head-master. Bishop Fox, the founder of the ancient school at Taunton, was rattened by the Oxford clergy for forcing the new study of Greek upon his college of Corpus Christi; his representative in Taunton shares his fate to-day, driven from the school which he has refounded for forcing on it the new study of science.

We write in no hope of assisting the head-master, or of educating his opponents into large-mindedness. Mr. Tuckwell will see his schemes collapse, and be parted from the profession in which all eagerly attest his success, and to which he has given the best years of his life. The school will either break up under the irritation of the parents, or its distinctive features will perish with the ruler who called them forth. The order of the old teaching, the assertion of the old theology, will resume their way in Taunton School. Chemistry, and physics, and botany; Shakspeare, and Milton, and Macaulay, and Guizot, will give way to gerund-grinding and Latin verse. Where Wesleyans, Independents, Quakers, Catholics, and Unitarians worshipped in the same chapel and attended the same scripture-classes, sectarian exclusiveness will re-enter its swept and garnished home. We can only chronicle the facts as indicating the obstacles to be met and reckoned with by the pioneers of modern educational progress. We can only express sympathy with the head-master, who will yet find some compensation for his worries in the unusual warmth of testimony contained in the address which first brought these circumstances to our knowledge, and in the consciousness that, having advanced a noble cause, his work will not in the end be thrown away.

ON DROPS

AMONG the many ways in which electricity is called in to give assistance in various physical investigations, one of the most elegant and interesting is the application of the electric spark to render momentarily visible a body that is rapidly moving or changing its form. The duration of the electric spark is so short—probably not more than $\frac{1}{24000}$ of a second—that a body, such as a rotating wheel or oscillating rod, moving in a dark room with extreme rapidity, will, if illumined by an electric spark, seem stationary, since the wheel or rod has not time to change its position appreciably during the short instant for which it is visible. If the spark be bright, the impression is left on the eye long enough for the attention to be directed to it, and for a clear idea to be formed of what has been seen.

The writer of this article has recently applied this method to watching the changes of form in drops of various liquids falling vertically on a horizontal plate. As usually seen, a drop of water falling from a height of ten or twelve inches on a smooth solid substance, such as glass or wood, seems to make an indiscriminate splash. The whole splash takes place so quickly that the eye cannot follow the changes of form; the impression made by the last part of the splash succeeding that of the first part so quickly as to confuse it.

A little careful observation, however, shows that the drop passes through very definite symmetrical forms, and that a splash is by no means an irregular hap-hazard phenomenon.

Let the reader let fall a few drops of milk, about $\frac{1}{4}$ inch in diameter, on a smooth dark surface of wood or paper, from a height of, say, six inches (milk is better than water, as it is easier to see, especially on a dark ground); he will observe that the liquid makes a blot with a more or less regular undulated edge, but the splash is too quick to follow with the eye.

Let him now substitute a drop of mercury for the milk. By watching the splash very intently he will be able to catch a glimpse of the mercury spread out in the symmetrical star-like form of Fig. II*a* of Set 2. After the drop has been thus spread out it recovers its globular form, since the mercury does not wet the plate. On increasing the height of fall a few inches, it will be noticed that small drops split off in a more or less complete circle, and are left lying on the plate, while the rest of the drop gathers itself together in the middle of the circle.

The chief reason why these appearances could not be seen with milk is that the milk wets the glass or wood and sticks to it, while the mercury does not. But by smoking a slip of glass or card tolerably thickly in the flame of a candle we get a finely-divided surface of lamp-black to which the milk does not adhere any more than the mercury, and by very careful watching we may notice that the same radial star is formed by the milk, but it is much more difficult to catch sight of than the mercury star. But if the mark on the lamp-black be examined after the drop of milk or mercury has rolled away it will be found to consist of delicate concentric rings with numberless fine radial striæ where the smoke has been swept away. These may be seen very well by holding the glass plate up to the light if it has not been too thickly smoked.

The marks thus made are very beautiful and symmetrical, and it will be found, if the glass be uniformly smoked, that the same-sized drops of the same liquid falling from the same height will produce almost exactly similar marks: while if the height be changed the mark on the lamp-black will be somewhat changed; and it is a fair inference, if each drop makes almost exactly the same complicated, symmetrical mark, that the splash of each drop takes place in almost exactly the same way.

The glimpse that may be caught of the drop in the way described is obtained when the drop is really almost stationary, having flattened itself out on the plate and being on the point of contracting again to its original form.

That a drop if so flattened out will recover itself is seen on pressing down a drop of mercury with the finger or a drop of water with a piece of black-lead or other substance to which it does not adhere. On removing the pressure the drop springs back to its old form; the force which causes this being exerted by the curved surface of the liquid at the edge of the flattened drop, on the liquid within. The flatter the drop becomes the greater is the curvature of the edge and the greater the corresponding pressure tending to restore it to its original globular form. The extent to which a drop that has fallen on a plate will spread out depends on the velocity with which it strikes the plate, *i.e.*, on the height of fall; so that as long as the drop returns to the globular form the whole phenomenon of the splash may be regarded as an oscillation similar to that of a pendulum; the velocity of the liquid outwards being checked, overcome, and finally reversed by the ever-increasing pressure of the curved edge, just as a pendulum has its velocity checked, overcome, and finally reversed by the action of gravity.

It is only when the height of fall is very great that the liquid flies off in all directions and the splash ceases to be an oscillation; this case corresponds to that of a simple pendulum started with a blow so violent as to break the string.

But the liquid star and the complicated pattern on the smoked glass show that the splash is not a simple spreading out of the drop equally in all directions to return again.

In order to observe the form of the drop at any given instant during the splash, it is necessary to make use of the electric spark and to take advantage of the fact that drops of the same size falling from the same height will all behave in the same way.

It will be necessary to let a drop, say of mercury, fall on a plate in comparative darkness, and to produce a strong spark at the instant the bottom of the drop comes in contact with the plate, and so illumine it; the observer will then see the drop in the form it has at that instant.

A second drop must be let fall in the same way, and be illumined by the spark not at the first moment of contact, but a shade later, say $\frac{1}{100}$ second later, when the drop will have spread itself out slightly on the plate, and similarly we must illuminate a third drop a shade later than the second, and so on. The observer can, after a little practice draw from memory on each occasion the drop in the form in which he has seen it. It will be seen that the process consists in isolating consecutive phases of the splash from those that precede and follow, and which take place in darkness and so do not confuse what has been seen as they would do in continuous daylight.

The device adopted by the writer for so timing the appearance of the spark as to illumine the drop at any desired phase of the splash consisted essentially in breaking the current of an electro-magnet at the instant the drop began to fall; the magnet thus ceasing to act, releases a spring which immediately begins to pull the terminal wire of a strong electric current out of the other terminal, which is a cup of mercury, and the strength of the spring and the depth of immersion of the wire in the mercury are so adjusted that the wire leaves the surface of the mercury, and the required spark is produced at the instant the drop reaches the plate.

For the next drop the spark is made to appear a shade later, either by slackening the spring or increasing the depth to which the terminal wire is immersed in the mercury.

The following figures have been drawn in the way described, and show the behaviour of a drop of mercury about $\frac{1}{7}$ in. in diameter, falling from a height of about three inches on to a glass plate. Each figure represents a rather later stage of the splash than the preceding.

Set 2 was drawn from the final stages of a milk drop, ¼ in. in diameter, falling 4 in. on to smoked glass; but the forms are almost identical with those of mercury. Of this set I*a* and II*a'* are vertical central sections of the middle part of the drop, while II*a* and III*a* are alternative forms of II and III.

From the ends of the rays of Fig. 4, usually twenty-four in number, small drops often split off. These are not

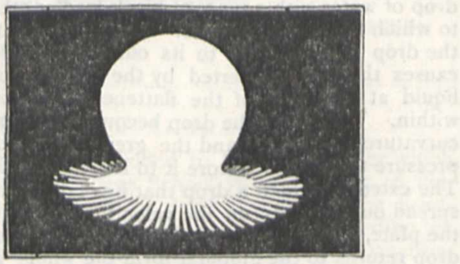


FIG. 1.

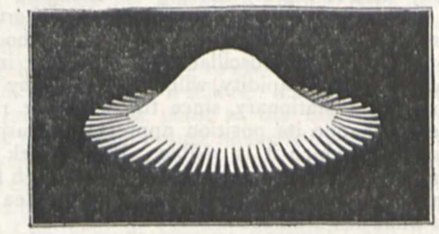


FIG. 2.

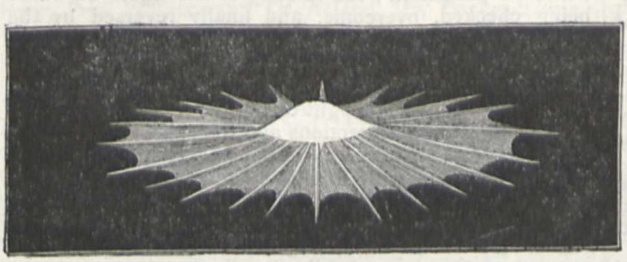


FIG. 3.

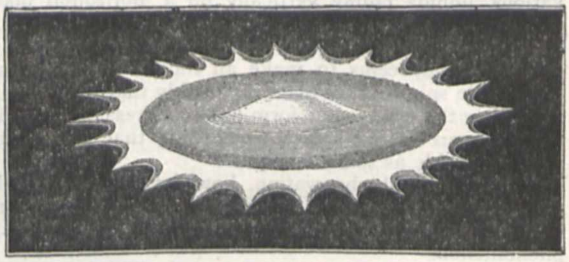


FIG. 4.

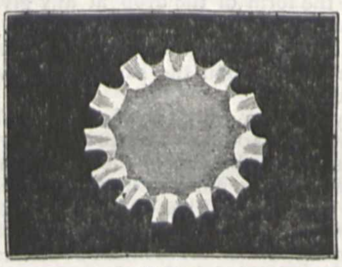


FIG. 5.

FIG. 6.

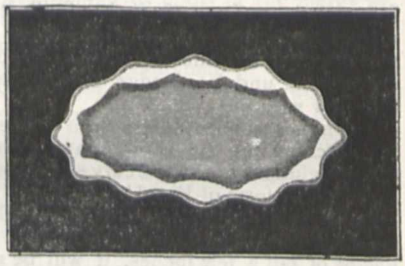


FIG. 7.

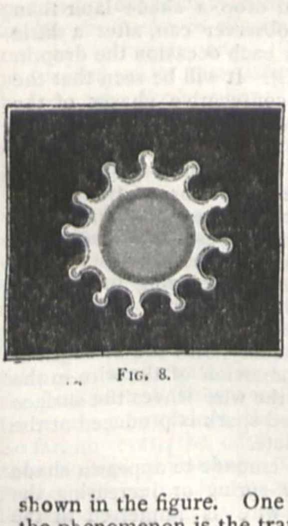
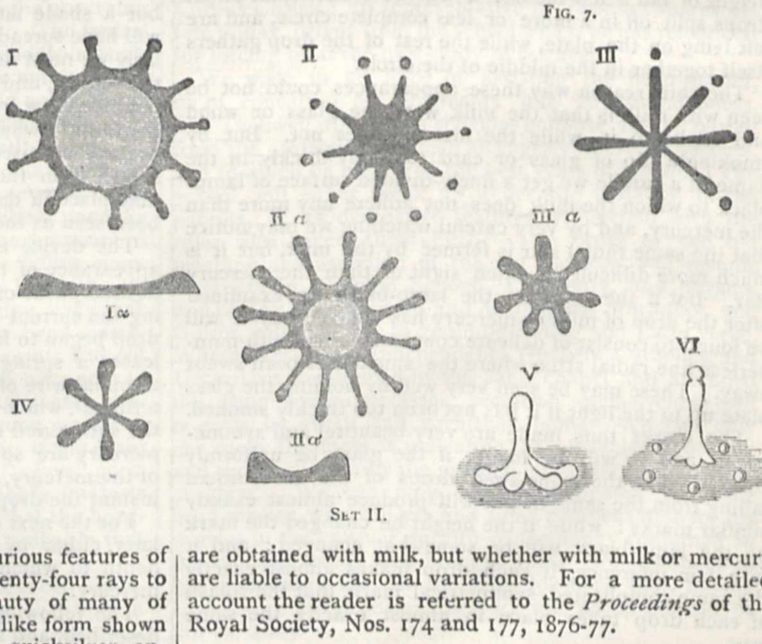


FIG. 8.



SET II.

shown in the figure. One of the most curious features of the phenomenon is the transition from twenty-four rays to twelve arms, shown in Fig. 5. The beauty of many of the forms, especially of the ridged shell-like form shown in Fig. 4, when composed of shining quicksilver apparently rigidly fixed, is very striking. Very similar forms are obtained with milk, but whether with milk or mercury are liable to occasional variations. For a more detailed account the reader is referred to the *Proceedings* of the Royal Society, Nos. 174 and 177, 1876-77.

A. M. WORTHINGTON

CHEMICAL NOTES

ON ERRORS IN THE DETERMINATION OF THE DENSITIES OF MIXED VAPOURS.—In the *Compt. Rend.*, lxxxiii., Messrs. Troost and Hautefeuille record some experiments made by them to discover the error which occurs in determining the vapour-density of substances by the application of the law of Dalton on the tension of mixed gases, and Boyle and Gay-Lussac's laws, as applied to a mixture of the vapour examined, either with air or with some other vapour. They examined a mixture of carbon and silicium chlorides, using a modified form of Gay-Lussac's vapour-density apparatus. On increasing the amount of carbon chloride, the tension of the silicium chloride diminished. The vapour-density of silicium chloride alone varied only from 5·94 to 6·0, but in presence of carbon chloride was found to increase 6·27 to 8·2.

ON THE PROPERTIES OF RUTHENIUM.—In the same journal an account is given by Messrs. St. Claire-Deville and H. Debray, on the physical and chemical properties of the above metal. They find that the metal forms an oxide RuO_2, thus differing from osmium. By fusing the pure metal with potash and saltpetre, then saturating the rutheniate thus formed with chlorine, and distilling in a current of the gas at about 80° C., they obtain the tetra-oxide RuO_4 in yellow crystals, which, when reduced, yields the pure metal. The metal they obtained by purification from its alloy with zinc, was found to have a density of 12·261 at 0°. They also obtained a compound, $Ru_2K_2O_8$, in black crystals, on saturating the rutheniate of potash with chlorine. For the analysis of ruthenium ores, the process they employ is based on the foregoing remarks. After the fusion of the ore with saltpetre and potash, the whole mass is distilled with chlorine, the excess of gas, together with the RuO_4, being absorbed by solution of potash. The potash solution is then treated with alcohol which precipitates the ruthenium as oxide, and this is finally reduced to the metallic state with hydrogen.

ACONITIC ACID IN CANE JUICE AND RAW SUGAR.—In a late number of the *American Chemist* an account is given by Dr. Arno Behr of some experiments he has conducted on the above subject. For examining the properties of this acid he has found the so-called melado a proper material, this substance being merely cane juice boiled down to a concentration such as allows the sugar to crystallise out, the mother liquor being then drawn off and used for the production of the acid. The author has analysed an acid substance formed by decomposing its ammonia compound with sulphuric acid and extracting with ether, and assigns to it the composition $C_6H_6O_6$. He has also prepared silver, calcium, and ammonium salts of the acid body, the per centage composition of these salts agreeing closely with the theoretical composition of the silver, calcium, and ammonium aconitates. Although from the results of his analyses he has no doubt of the substance in question being aconitic acid, yet the melting point, 172-173° C., which he found was not in accordance with that generally given, viz., 140° C.° ; the author therefore prepared some pure acid which had a melting point of 168-169° C. The acid formed from aconitine fused at 165° C. It is difficult, however, to determine the melting point as the acid is decomposed in the process of melting. The author has found the melado to contain 0 149 per cent. of aconitic acid. The sweet waters from charcoal filters used in refining raw sugar contain it in an appreciable quantity, and some molasses sugars give a peculiarly opaque solution from which a sandy sediment is deposited, appearing under the microscope to consist of small rhombohedral crystals, and which, on analysis, proved to be calcium aconite. The author thinks aconitic acid to be a normal constituent of sugar, and that it is worthy of remark that the two plants yielding the most sugar—the beet-root and sugar-cane—also produce two acids standing so chemically near each other as citric and aconitic acids, and which contain in their molecules the same number of carbon atoms as fruit sugar.

MINERALS CONTAINING COLUMBIUM FROM NEW LOCALITIES IN THE UNITED STATES.—Mr. J. L. Smith, of Louisville, has examined several species of minerals containing columbium, and claims the restoration of this name for the metal instead of that of niobium, generally given to it in England and on the Continent. His reason for making this reclamation is that the name niobic acid was incorrectly given by H. Rose to one of the acids found by him in his researches on the columbite of Bodemais, and subsequently proved by him to be identical with the columbic acid originally discovered by Hatchett in 1801. The name niobic acid, however, given by Rose, has never been altered, and Mr. Smith thinks the original columbic acid should have been retained. In remarks on the chemical constitution of the minerals described by him, Mr. Smith thinks that the composition of the columbates, although appearing at first sight complex and irregular, becomes much simpler when due allowance is made for the intermixture of the different varieties with each other. Columbite, the best known of the minerals, can be well recognised as a simple columbate of iron and manganese ; microlite appears to be a columbate of lime ; pyrochlore, a columbate of the cerium oxides and lime, but whether or not a neutral columbate remains to be investigated. Hatchetolite he considers as a neutral columbate of uranium and lime, and samarskite a basic columbate of iron, uranium, and yttrium oxides. Yttrotantalite and euxenite are basic columbates of yttrium and uranium, the first being anhydrous when pure, the second containing water. Fergusonite is a hydrated basic columbate of yttria, and Rogersite, a columbate still more basic. In arranging a general view of these minerals Mr. Smith does not take into account the constituents which exist in small quantities only.

COEFFICIENT OF CAPILLARITY FOR CERTAIN LIQUIDS.—M. Gueront, in the *Comptes Rendus* (lxxxiii. 1291) describes experiments in which he finds that in any series of organic compounds the coefficient of capillarity decreases as the amount of carbon in the substance increases. He has examined three series of bodies, the fatty acids, the acid ethers of ethylic alcohol, and the ethers formed by the union of acetic acid with the different fatty alcohols. In the series of fatty acids those members above propionic acid agree with the above statement, but the two lowest members, acetic and propionic acids, are exceptions ; this he thinks probably due to impurities ; the two series of ethers, however, agree perfectly with the law. From his observations it becomes evident that the coefficient of capillarity of the ethers is higher than that of the alcohols or the acids from which they are formed, showing that the introduction of an organic radical into the alcohol molecule renders the body more fluid. On comparing the two series of ethers it was found that the isomeric ethers have nearly the same coefficient, but the acids isomeric with them are much lower. Thus valeric acid, which is isomeric with ethyl propionate and propyl acetate, has a coefficient only about one quarter that of these latter. The reason suggested for this difference is that in the two isomeric ethers atoms are grouped in a similar way, while in the isomeric acids the grouping is different.

METEOROLOGICAL NOTES

SUN-SPOT PERIODS AND AURORAS FROM 1773 to 1827.—We have received a communication from Mr. Buchan inclosing the following table, showing the number of auroras observed by Mr. James Hoy at, or in the vicinity of, Edinburgh, each year from 1773 to 1781, and at Gordon Castle, Banffshire, from 1781 to 1827 :—

Year.	Sun-spots.	Auroras.	Year.	Sun-spots.	Auroras.
1773	40	5	1801	39	2
1774	48	5	1802	58	2
1775	28	1	1803	65	6
1776	35	3	1804	75	5
1777	63	0	1805	50	2
1778	95	6	1806	25	2
1779	90	11	1807	15	1
1780	73	6	1808	7	1
1781	68	2	1809	3	1
1782	33	3	1810	0	0
1783	22	2	1811	1	0
1784	5	0	1812	5	0
1785	21	0	1813	14	0
1786	89	10	1814	20	1
1787	105	12	1815	35	1
1788	108	9	1816	45	1
1789	111	22	1817	44	3
1790	84	4	1818	34	1
1791	53	6	1819	22	5
1792	47	1	1820	9	3
1793	40	2	1821	4	1
1794	34	1	1822	3	0
1795	22	1	1123	1	1
1796	15	3	1824	7	2
1797	8	1	1825	17	0
1798	4	0	1826	29	0
1799	10	1	1827	40	1
1800	18	0			

This table is of peculiar value with regard to the many questions at present under discussion in connection with sun-spots.

SUN-SPOTS AND THE PREDICTION OF THE WEATHER OF THE COMING SEASON AT MAURITIUS.—In the *Monthly Notices*, new series, No. 1, of the Meteorological Society of Mauritius (December 21, 1876), Mr. Meldrum gives a clear and interesting summary of his researches into the relations of sun-spots to several atmospheric phenomena. A valuable table appears on p. 14 setting forth the number of cyclones which have occurred in the Indian Ocean between the equator and 34° lat. S. each year from 1856 to 1875, the total distances traversed by these cyclones, the sums of their radii and areas, their duration in days, the sums of their total areas, and their relative areas. The well-known thoroughness with which the Meteorological Society of Mauritius has worked at the storms of the Indian Ocean ensures that the subject has been exhaustively treated. The period embraces two complete, or all but complete, sun-spot periods, the former beginning with 1856 and ending 1867, and the latter extending from 1867 to about the present time. The broad result is that the number of cyclones, the length and duration of their courses, and the extent of the earth's surface covered by them all reach the maximum in each sun-spot period during the years of maximum maculation, and fall to the minimum during the years of minimum maculation. The peculiar value of these results lies in the fact that the portion of the earth's surface over which this investigation extends is, from its geographical position and what may be termed its meteorological homogeneity, singularly well fitted to bring out prominently any connection that may exist between the condition of the sun's surface and atmospheric phenomena. A drought commenced in Mauritius early in November, 1876, and when the paper was read on December 21, Mr. Meldrum ventured to express publicly his opinion that probably the drought would not break up till towards the end of January, and that it might last till the middle of February, adding that up to these dates the rainfall of the island would probably not exceed 50 per cent. of the mean fall. This opinion was an inference grounded on past observations, which show that former droughts have lasted from about three to three and a half months, and that these droughts have occurred in the years of minimum sun-spots, or at all events in years when the spots were far below the average, such as 1842, 1843, 1855, 1856, 1864, 1866, and 1867, and that now we are near the minimum epoch of sun-spots. It was further stated that the probability of rains being brought earlier by a cyclone was but slight, seeing that the season for cyclones is not till February or March, and that no cyclone whatever visited Mauritius during 1853–56 and 1864–67, the years of minimum sun-spots. From the immense practical importance of this application of the connection between sun-spots and weather to the prediction of the character of the weather of the coming season, we shall look forward with the liveliest interest to a detailed statement of the weather which actually occurred in that part of the Indian Ocean from November to March last.

METEOROLOGY IN SOUTH AUSTRALIA.—The publication of the meteorological observations made in this colony, which required to be discontinued in 1870 owing to the heavy pressure of official duties devolving on Mr. Charles Todd in connection with the construction and organisation of the Overland Telegraph, was resumed in an extended form in January, 1876, and we have now before us the first nine monthly issues, which bring the publication down to the end of September last. The reports detail, with some care, the conditions under which the observations are taken, the three or six daily observations made, and full *résumés* of the monthly results. An extremely valuable part of the reports is the monthly table of the rainfall at upwards of eighty stations, as observed by the officers of the postal and telegraph departments, and a number of volunteer observers who have co-operated with Mr. Todd in observing the rainfall for many years. The stations are arranged in geographical order from north to south, commencing with Port Darwin on the north coast, and along with the monthly amounts there are also given the averages of the month at all those places at which at least seven years' observations have been made. Among the many points of interest offered by these tables are the torrential rains of the north coast in the first three months of the year, frequently rising to from ten to sixteen inches in the month, their rapid diminution on advancing inland to Barrow's Creek or Alice Springs, and the great diminution in April, and the rainless, or all but rainless character of the northern region from June to September, when the prevailing winds of Australia become decidedly continental, or blow from the interior seawards. Since it would be impossible to over-estimate the importance of barometrical and thermometrical observations from this extended network of stations in South Australia, we very earnestly hope that the Colony will soon take steps to obtain these observations and publish them in the interest of meteorology.

RAINFALL OBSERVATIONS IN THE EAST OF FRANCE FROM 1763 TO 1870.—In the *Bulletin Hebdomadaire* of the Scientific Association of France, of the 10th instant, Prof. Raulin gives an interesting historical account of all the rainfall observations made during these 108 years anywhere in that section of France which is marked off by lines joining Givet on the Meuse, Lauterbourg on the Rhine, Belley near the Rhon, and Decize on the Loire, and which thus comprehends seven well-marked regions, viz., the plain of Alsace, the chain of the Vosges, the plateaux of Lorraine and Bourgogne, the plains of Champagne and Bresse, and finally the chain of the Jura mountains. During the past three years Prof. Raulin has been engaged collecting all available materials for a monograph on the rainfall of this part of Europe, which, judging from his great monographs of the rainfall of other sections of France and of the rainfall of Algeria, will doubtless take its place as a permanent contribution of very high value to meteorological science.

IOWA WEATHER REPORT.—We observe from a circular issued by Prof. Gustavus Henrichs to the volunteer observers of Iowa (U.S.), that his report of the observations made at the meteorological stations of that State during 1876 is to be published as an Appendix to the *Report of the Iowa State Agricultural Society*, and that as the monthly reports are published in fully twenty of the newspapers, the *Weather Review* will be discontinued. The *Weather Report* about to be published will embrace an account of the meteorological system now in full operation over the State, and discussions of the rainfall, storms, and other phenomena, the normals which have been ascertained for different localities, and the detailed observations made at the Central Weather Station.

OUR ASTRONOMICAL COLUMN

THE SATURNIAN SATELLITE, HYPERION. — Prof. Asaph Hall, in *Astron. Nach.*, No. 2,137, publishes an ephemeris of this faint object about the approaching opposition of Saturn, with the view to facilitate observations, especially near the conjunctions. He remarks that although the satellite was discovered (by Bond and Lassell) nearly thirty years since, the difficulty of observing it has been so great that no satisfactory determination of its orbit has been practicable; most of the observations being made near the elongations, the position of the plane of the orbit is not accurately deducible therefrom, though it probably does not coincide with the plane of the ring, but appears to lie between those of Titan and Japetus. With the view to assist observation in the present year Prof. A. Hall has calculated elements from his observations in 1875, which may be stated as follows:—Perisaturnium passage, 1875, August 24·0036 mean time at Washington; distance of perisaturnium from the node 40° 0′, eccentricity 0·125, semi-axis major 214″·22, period of revolution 21·3113 mean solar days. For the reason stated above it is supposed for this approximate orbit that its plane coincides with that of the ring, the node of which on the earth's equator is assumed to be in 126° 9′·1, and its inclination thereto 7° 3′·8. From these data auxiliary quantities and an ephemeris for Washington midnight, August 1–September 15, are added, and it is suggested that with the aid of the former comprising the interval June 1–December 28 a more accurate calculation may be made by Mr. Marth's formulæ.

Taking the solar parallax at 8″·86 Prof. A. Hall's elements would give for the mean distance of Hyperion from the centre of Saturn 914,000 miles, distance in perisaturnium 800,000, in aposaturnium 1,028,000 miles.

The first computation of the orbit of this satellite was by the late Prof. G. P. Bond, of Cambridge, U.S., from his distances observed between 1848, September 19, and January 12 following; his period of revolution is 21·18 days, mean distance 214″, eccentricity 0·115; the elements will be found in the *Proceedings* of the American Academy of Arts and Sciences.

THE TRIPLE-STAR 7 CAMELOPARDI.—The third component of this triple star was detected by Baron Dembowski on September 28, 1864, having been overlooked by Struve at Dorpat, who measured A and B in 1831, his mean result being 1831·57, pos. 238·32°, dist. 25·647″. The Galarate epoch for the new companion is (A C) 1865·33 pos. 308°·83, dist. 1″·245. Baron Dembowski says the object was one of great difficulty for his refractor principally on account of the sombre hue of the star C, which did not appear always of the same intensity; referring to his observations at the epoch 1865·25, he remarks, "Elle avait alors une couleur de cendre mouillée; je n'ai jamais vue d'étoile aussi sombre.' His magnitudes of C in 1864-5 vary from 7·0 to 9·0, while in the middle of November, 1865, he could not perceive the least trace of the star. Mr. Crossley measured A B at the end of December, 1873, but has no reference to the third star. The object will be worth watching on the score of variability and the unusual duskiness noted by the Galarate observer.

THE CAPE ASTRONOMICAL RESULTS FOR 1874.—Mr. Stone has just circulated his volume of observations made at the Royal Observatory, Cape of Good Hope, in 1874, being the thirteenth separate publication which has emanated from this important and active astronomical establishment since the year 1871, when Mr. Stone undertook its direction. We believe there is not a refinement in observing or computing which is not introduced into the Cape work, and the results have consequently a very high value, comparable with the best work of the kind published by the great European and American observatories, where attention is given to stellar astronomy. The volume for 1874 contains the mean positions of 1,246 stars, including all Lacaille's stars of the *Cœlum Australe Stelliferum*, which now fall between 155° and 165° of north polar distance, and some additional ones in the same zone. Lacaille's stars between N.P.D. 145° and 155° were similarly observed in the course of the year 1875, and those between N.P.D. 135° and 145° in 1876, the reductions to mean places for the former zone having been completed at the beginning of the present year. A complete determination of the accurate places of all Lacaille's stars, founded on the Cape observations, is therefore in a very forward state.

As an appendix to this volume of Cape Observations, Mr. Stone presents tables intended to facilitate the computation of star-constants, which appear likely to prove of very great service to the practical astronomer. By a slight modification of Bessel's form for star-corrections he has been able to tabulate the quantities in a very convenient and compendious manner, so that the whole computation occupies but a short time. Mr. Stone hopes that the use of these tables may render it unnecessary to give star-constants for every star contained in future catalogues, the labour of forming which, and of insuring their accuracy is very great. It is probable, as he observes, that the use of star-constants in various catalogues has been in many cases extended beyond the time when they could be introduced with a due regard to the precision required in modern stellar astronomy, which will be obviated by the use of the tables in question. It is understood that Mr. Stone liberally offers to supply a copy of these tables to anyone who would find them of real service, and who will make application for them. A few remarks on the *modus operandi* with the tables are reserved for a future column.

THE BRITISH ASSOCIATION AT PLYMOUTH

FEW towns in the United Kingdom have so much to interest alike the scientific and the general visitor as Plymouth; and the meeting there of the members of the British Association in August next should prove alike pleasant and profitable. For the general visitor it will perhaps be enough that the Plymouth Hoe is one of the finest promenades in England, and that the landscapes of the neighbourhood are at once most varied and most attractive. The man of science will be able to enjoy all this and a good deal more. The zoologist may if he pleases revel in dredging expeditions in and off the Sound, which are sure to yield an ample reward. For the mechanician there are three of the most no able works of modern engineering skill to inspect—the Eddystone Lighthouse, the Plymouth Breakwater, and the Royal Albert Bridge, while the Government dockyards and factories at Devonport and Keyham, and the war vessels which stud the Hamoaze, will have a general as well as a special interest. One of the most enjoyable excursions of the Exeter meeting was that to the Three Towns, on which occasion the Government establishments were visited and gunnery and torpedo practice, with all the latest electrical arrangements, witnessed on board the *Cambridge*. The science of war has by no means stood still since then. The botany of the locality presents some peculiar features, and the algology is very rich.

In the domain of natural science special interest however attaches to the local geology. Plymouth rivals Torquay in its development of the great Devon limestone, which lines the northern borders of the twin estuaries of the Tamar and the Plym, along which the Three Towns are built, and trending southward and eastward, occupies the northern shores of Cattewater, and after a break reappears in mass at Yealmpton. The Hoe is limestone—a natural esplanade, an ancient plateau of denudation, with occasional alluvial deposits of sand and clay in pockets and fissures, remains of raised beaches, and a few ossiferous cavities. The limestone abounds in fossils, coralline in the more massive portions as a rule, but with areas crowded with molluscs of the ordinary Devonian type. Its chief palæontological interest lies, however, in its bone caves. The ossiferous caverns of Oreston, a little village on the southern bank of Cattewater, which were discovered originally in the course of quarrying the stone for the breakwater, whilst other members of the series have been opened from time to time since, are well known by description at least to geologists. Those of Yealmpton have hardly attracted so much attention. The fauna differs in both series in some important particulars from that of Kent's Cavern, though including in each case the ordinary cavern carnivora. The whole literature of the Oreston and Yealmpton caverns will be found in the *Transactions* of the Devonshire Association, compiled by Mr. Pengelly. And if the palæontologist should then feel special interest in a locality which has yielded so much to his branch of science, the stratigraphical geologist will find some notable materials for the study of the "still-vexed Devonian question" in the sections along the eastern shore of the Sound and elsewhere. The cliff section from Mount Batten, by Staddon Heights and Bovisand to the mouth of the Yealm has been described by Sedgwick, Murchison, de la Beche, Phillips, Holl, Pengelly, Jukes, and other eminent geologists, and interpreted very diversely, though the balance of opinion still remains that its shales and sandstones overlie the limestone. The contortions and plications are, however, in some parts very remarkable, and should be studied *in situ*.

There is nothing very noteworthy in the immediate mineralogy of Plymouth, but the mining districts of Cornwall and Devon, within easy reach, are the richest mineralogical field in the kingdom, and in the barrows circles, cromlechs, pounds, dolmens, and menhirion, still scattered in profusion over the wild flanks of Dartmoor, and along many a Cornish moorland, the anthropologist will find plenty to delight him. Upon the importance of the contributions of Kent's Cavern to the early history of man we need not dilate. The results of the explorations there, with the literature of the cavern, prepared by the indefatigable pen of Mr. Pengelly, will be found in the Devonshire Association *Transactions*.

The Plymouth Institution, with which is amalgamated the Devon and Cornwall Natural History Society, and which fittingly took the initiative in proposing the invitation of the Association, is the centre of the scientific life and work of the neighbourhood. It is a society of some standing, for it was founded so far back as the year 1812, and its members have done much to elucidate science in its connections with the district, and to cultivate literature and the fine arts. The natural history section of its museum is rich in local ichthyology, and fair in some other departments of its fauna. There are some very valuable antiquities; and the mineralogical and geological collections, though far from complete, are by no means wanting in interest. Bones from the ossiferous fissures on the Hoe, the caverns at Oreston and Yealmpton, and from Kent's Hole, form a prominent feature of its palæontology; and there are a few specimens which have a special value in having been presented by the Rev. Richard Hennah, who first established the fossiliferous character of the Plymouth limestone. The Institution issues *Transactions*, and has published some valuable papers bearing alike on science and upon local history, topography, and literature, from the "Law of Electrical Accumulations," by Sir W. Snow Harris, F.R.S.; to a paper "On the Letter R," by R. F. Weymouth, D.Lit. It will be evident, therefore, that the institution has been doing good work.

But now for some particulars concerning the local arrangements. These are in the hands of a large and influential executive committee, with sub-committees for the chief departments—finance, reception, sectional, excursion, fine art, &c. The mayor is the chairman of the executive; the secretaries being Messrs. W. Adams, W. Square, and H. Whiteford, while Mr. F. Hicks is the treasurer.

In one respect, and that a most important one, Plymouth will distance almost every town the Association has visited. We allude to the convenience of its sectional accommodation. The great hall of the Plymouth Guildhall, with its royal statues and magnificent historic windows, is the noblest hall in the whole south and west of England. Here the president will deliver his address and the evening meetings be held. In the law courts adjoining, and the spacious rooms of the municipal offices, some of the sections will be accommodated. Others will meet at the Mechanics' Institute, the Athenæum, and the Royal Hotel, the whole of which are within less than five minutes' walk of the Guildhall and each other. Since one or two of the other section rooms were decided on, it has been suggested that the sections to which they were appropriated may also be accommodated within the limits first indicated; but whether that be so or not, in the most remote case the most distantly located sections will only be six or seven minutes' walk apart. The members of the Association will know how to appreciate this.

Close by the Guildhall is St. Andrew's Hall, a large building recently erected as a skating rink. This will be utilised in connection with the Association for an exhibition of the fine arts. Plymouth is the artistic centre of Devon and Cornwall, which have given birth to many famous painters, and the exhibition is intended to be specially representative of western art. The Queen is among the contributors, and leading residents throughout the two counties. Living artists will be well represented; but the staple of the exhibition will consist of examples of Reynolds, Opie, Eastlake, Prout, with Haydon, Northcote, and other artists of note. With the exception of Opie, who was a Cornishman, and Reynolds, who was born at Plympton, four miles off, the artists here named are Plymothians.

Every effort is being made to get up an enjoyable and scientifically interesting series of excursions. It is perhaps rather a disadvantage in one way that the neighbourhood of Plymouth should be so beautiful, for therein lies a strong temptation to let fine scenery get the better of hard science. However, it so happens that there is very little difficulty in combining both. In 1841 there was but one excursion—to Tavistock and Wheal Friendship. This year there are six proposed—three for the Saturday and three for the Thursday following, in addition to which the Earl of Mount-Edgcumbe has most kindly consented to open his magnificent park on the Saturday to the members. The botanists will need no excuse for visiting Mount-Edgcumbe; if the geologists do they may find it in the interesting intrusive rocks at Cawsand, referred to in De la Beche's Report. One of the excursions proposed for Saturday is by steamer to the breakwater, and Smeaton's famous work, the Eddystone Lighthouse, winding up with a trip round the harbour, with its men-of-war, dockyards, forts, and factories. The Government establishments are always open to English folk. Our foreign friends who may desire to go over them, will have to provide themselves with a special order. There will be also a trip to Liskeard, for the Caradoc and Phœnix mines, and the famous Cheesewing. As mining is the special industry of Cornwall, and to a great extent of South Devon, it has been thought desirable to have two mining excursions—one on each day. South Caradoc is one of the richest copper mines in Cornwall; Phœnix is a tin mine; and both are admirably managed and excellently adapted to illustrate mining operations. The mineralogy of this district has some peculiar features. Phœnix has lately yielded the rare minerals chalcosiderite, andrewsite, and the beautiful turquoise-hued henwoodite. The third excursion will be to the Lee Moor China clay works. These are situated on the skirts of Dartmoor, not far from Plympton, are of immense size, and afford probably the best illustration of this great industry, which Cornwall and Devon owe to the researches and ingenuity of Cookworthy, chemist and potter, manufacturer in the Plymouth china of the first true English (hard) porcelain. It is likely that this excursion will be taken up by the Plymouth Institution, and so arranged as to embrace a visit to Princetown, and its convict prison, and some of the fine prehistoric antiquities of Dartmoor; if not there will probably be an extra excursion with this object given by the institution.

Thursday will be a long day, and wholly given up to excursion pleasures. The mining excursion will be up the lovely river Tamar to Devon Great Consols, which communicates by a railway of its own to shipping quays at Morwellham, in the close vicinity of the most picturesque scenery of the Tamar valley. On the way, by the kindness of the Countess Dowager and the Earl of Mount-Edgcumbe, the party will have an opportunity of inspecting Cotehele, one of the most perfect examples of a mediæval mansion now extant. At Devon Consols—not long since the largest and richest copper mine in the land, which gave in dividends considerably over a million—not only are mining operations conducted on the most extensive scale, but there are enormous arsenic works, huge water-wheels, and many other objects of interest. The other excursions arranged for the day are to Torquay and Penzance. The good people of Torquay intend to follow the capital precedent set in 1869, and to invite and entertain a number of guests. *En route* from Plymouth a steamer trip may be made down the lovely river Dart; and at Torquay there are plenty of objects of interest. The Torquay Natural History Society has a well-stored museum; Kent's Cavern is of course a museum in itself, with a very Cerberus of a curator in Mr. Pengelly; and then there are the works of Mr. Froude, F.R.S., at Chelson Cross, where he conducts those delicate experiments for the Admiralty on the forms of ships and their properties of stability, and to which he intends to invite members of the Association who are specially interested in this branch of mechanical science. Steps are, we believe, being taken at Penzance to give the excursionists thither a hearty welcome. The museums of the Penzance Natural History Society and of the Royal Geological Society of Cornwall, the latter of which contains the best public mineralogical collection in the West of England will be thrown open to them, and excursions in all probability organised to the chief attractions of the neighbourhood. It is hoped to provide special railway facilities for those who may wish to visit other parts of the country—such as Tintagel or the Lizard, or the western mining district. At Truro is the excellent museum of the Royal Institution of Cornwall, which will be open to visitors.

The former meeting at Plymouth, of the Association, was in 1841, with Dr. Whewell, as president, and was a very successful gathering. Six-and-thirty years are a long time, and it is remarkable that so many who took a prominent part on that occasion are yet with us. One of the vice-presidents still survives—the Earl of St. Germans; two of the local secretaries, Mr. R. W. Fox, F.R.S., and Mr. R. Taylor, F.G.S.; a vice-president of the statistical section, the Earl Fortescue, then Viscount Ebrington; Dr. Owen, F.R.S., vice-president for Zoology and Botany; and Mr. Robert Hunt, F.R.S., then secretary of the section of Chemistry and Mineralogy, are still with us. There will not be wanting opportunity, therefore, of comparing personal experiences in 1841 and 1877.

INDIAN RAINFALL AND SUN-SPOTS

ON May 24 Gen. Strachey read a paper before the Royal Society entitled "On the alleged Correspondence of the Rainfall at Madras with the Sun-Spot Period, and on the True Criterion of Periodicity in a Series of Variable Quantities."

He stated that a paper had recently been printed by Dr. Hunter, the Director-General of Statistics to the Government of India, having for its object to show that the records of the rainfall at Madras, for a period extending over sixty-four years, establish a cycle of rainfall at that place which has a marked coincidence with a corresponding cycle of sun-spots—the rainfall and sun-spots attaining a minimum in the eleventh, first, and second years, and a maximum in the fifth year.

The Madras register extends over sixty-four years, beginning with 1813. The mean rainfall for the whole period is 48·5 inches. The deviations from the mean vary from 30·1 inches in defect to 39·9 inches in excess. The arithmetical mean of these deviations (disregarding the signs) is 12·4 inches.

Dr. Hunter divides the sixty-four years' observations into six cycles of eleven years, and calculates the arithmetical mean of the successive years of the whole series of cycles. The results are as follows:—

	Years of cycles of eleven years.										
	1st.	2nd.	3rd.	4th.	5th.	6th.	7th.	8th.	9th.	10th.	11th.
Average difference from the mean of 64 years.	in. +0·6	in. +0·7	in. +9·8	in. +2·4	in. +1·9	in. +5·8	in. +4·4	in. −3·4	in. −11·5	in. +0·7	in. −13·5

In the above calculation the first year of the cycle of eleven is 1813, so that the average period of maximum sun-spots will be about the third or fourth year of the cycle, and the period of minimum will be about the tenth or eleventh of the cycle. This table apparently indicates a period of maximum between the third and the seventh years, and of minimum between the eighth and the second years.

But as the only signification of the arithmetical mean value of a series of observed quantities is that it is one above and below which there is an equal amount of deviation in the individual observations, the question whether or not the mean values thus obtained can be accepted as showing a definite law of variation from year to year in the cycle must be determined by examining the differences between those means and the individual observations on which they are based.

Treating the observations in this manner, it appears that the mean difference of the individual observations from the means shown in the table amounts to 11·2 inches, and differs but little from the mean difference of the individual observations from the arithmetical mean of the whole series. In other words, the supposed law of variation obtained from the means of the six eleven-year cycles hardly gives a closer approximation to the actual observations than is got by taking the simple arithmetical mean as the most probable value for any year.

In order to obtain a practical test of the probable physical reality of the cycle of eleven years, the author calculated a series of mean values corresponding to those given in the table for a series of cycles of five, six, seven, eight, nine, ten, twelve, and fourteen years. The mean differences between these means and the observed quantities are all within a very small fraction of one another, and of the mean obtained from the eleven-year cycle—

in short, one cycle is in this respect almost as good or as bad as another.

Now, if in any series of quantities, such as the rainfall observations at Madras, there be a law of periodicity, each observed quantity may be supposed to be compounded of a periodical and a non-periodical element. If we take the sum of a large number of cycles, each of which coincides with the cycle of periodicity, the non-periodical elements will tend to be eliminated, and the means for the successive years of the cycle will indicate the periodical elements for the successive intervals. At the same time the differences of these means from the several original quantities from which they were obtained will be the several non-periodical elements.

In proportion as the periodical elements are small or large in relation to the corresponding non-periodical elements, so the differences (obtained as above) will be inversely less or more different from the differences between the individual observations and the mean of the whole of them; and if there be no periodicity, the two sets of differences would, in a sufficiently long series, be identical.

Hence it may be inferred that when the differences (taken as before) closely approximate in magnitude to the mean difference of the original observations from the arithmetical mean of all of them, the periodical elements in those observations must be correspondingly small; and this applies manifestly to the eleven year-cycle and to the whole of the arbitrary cycles for which the differences were calculated.

Further to test the reality of the periodicity, the author re-arranged the series of sixty-four years' observations, in a purely arbitrary manner, in cycles of eleven years, by drawing the actual observations at random one after another, and setting them down in succession till the whole were exhausted. From three arbitrary cycles thus prepared, the differences averaged 10·9, 11·2, and 11·6—results which again indicate that the actual sequence of the observed quantities of rain has no material effect on the mean differences, or any such tendency to a diminution in their numerical value, which is the necessary accompaniment of a true periodical element.

Moreover, the mere circumstance of any series of cyclical means showing a single maximum and single minimum gives no real indication of such a result being a truly periodical feature. It is obviously to argue in a circle, first to assume a cycle on which to work, which shall give a single maximum and minimum, and then to infer that there is true periodicity because of the single maximum and minimum. The test of the periodicity is in truth to be sought altogether outside of the particular values of the successive elements of the cyclical means.

It is manifest that a complication of periodical elements may so mask one another as to prevent positive results being obtained by the examination of the means and differences in the case before us. But the whole scope of the present argument is negative, and it leads to the conclusion that there is no proof of greater tendency to periodicity in the eleven-year means than in the original isolated observations.

As the sun-spot period is not exactly a cycle of eleven years, the author examined the results obtained by a comparison of the observations corresponding to the known periods of maximum and minimum sun-spots, without reference to any special length of cycle. These results he also considered to be negative.

A further test of the character of the conclusions was sought from the rainfall observations at Bombay and Calcutta, which have been made for the greater part of the period over which those at Madras extend. It is hardly conceivable that there should be a coincidence with the sun-spot period, such as is supposed to have been found at Madras, based on any physical cause, which should not in some way be discernible in the rainfall at Bombay and Calcutta.

The results thus got are also held to be entirely negative, and to indicate no concordance among the means of the several years of the cycle at the different places. The Bombay and Calcutta observations, treated as those of Madras were, to ascertain the deviations of individual observations from the successive means of the cycle, give quite similar results.

Although the special object of the communication was to deal with the alleged correspondence between the Madras rainfall and the sun-spot periods, the author had also turned his attention to Mr. Meldrum's speculations of a similar character, and had tested some of them in the manner explained.

Among these were the Greenwich observations for fifty-five years, which will be found at p. 307 of vol. xxi. of the *Proceedings* of the Royal Society, and the results got from them were quite analogous to that obtained from the Indian observations.

Further, to illustrate the argument on which the paper was based, the case was considered, in which a well-ascertained periodicity exists, as that of the diurnal barometric oscillation. The figures used were taken at random from an old Madras register, the intervals being made two-hourly, and the entries and the differences of the observed barometric heights from the daily means in thousandths of an inch, so as to reduce the calculations.

The figures being merely illustrative, the circumstance of their not exactly representing any physical phenomenon, was a matter of no significance.

The treatment of these figures led to results very different from those got from the rainfall observations. The mean difference of all the supposed observations from the mean of all of them being thirty, the mean of the differences between the two-hourly means and the original figures was reduced to seven, indicating the distinct presence of a periodicity.

Re-arranging the figures in an arbitrary cycle of ten periods instead of twelve, the mean of the differences which before was seven was increased to thirty, showing that with the total destruction of the periodicity the mean difference of the two-hourly means and the original figures was the same as the mean difference with the arithmetical mean of all of them.

In conclusion, the author specially explained that he did not call in question the possible or actual occurrence of terrestrial phenomena corresponding to the sun-spot period, but only desired to point out that in the case of the rainfall observations under review the evidence was not sufficient to establish either any periodicity or such a correspondence.

In some remarks made subsequently the author pointed out how the comparison of the successive combination of the observations, beginning with one cycle and then combining two, and so on, till the whole were united, supplied another way of treating the figures which showed that the successive means of the differences between the mean rainfall for the combined cycles and the mean for the several years of the cycle when combined, followed the law that would hold good if there were no appreciable periodicity, that is to say, that this mean should gradually diminish in a ratio inverse to the square root of the number of cycles combined.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—Prof. Humphry has been appointed to represent the University at the 400th anniversary of the University of Upsala in September next.

Prof. Adams' report to the observatory syndicate for the year from May, 1876, to May, 1877, does not contain anything of unusual interest. The year has been exceptionally favourable for astronomical observations, and 3,618 observations were made with the Transit circle. All the publications of the observatory are well forward, and the general work has been carried on smoothly and efficiently.

The following awards have been made for proficiency in natural science at St. John's College:—To F. T. S. Houghton, a foundation scholarship, the Wright's Prize, and augmentation of exhibition to 100*l*. for the past year. To Marr, Slater, F. J. Allen, Stewart, augmentations of exhibitions.

LONDON.—A public meeting in support of the London School of Medicine for Women was held the other day at St. George's Hall, the especial object being to raise 5,000*l*., with a view of enabling the Executive Council to carry out an arrangement with the authorities of the Royal Free Hospital, under which students from the school were to receive clinical instruction. Mr. Cowper-Temple, M.P., Mrs. Garrett-Anderson, and Mrs. Westlake were amongst the speakers. 2,600*l*. have already been subscribed.

The Senate of the London University have decided by a majority of five not to postpone giving medical degrees to women till all the other faculties were open to them.

MANCHESTER.—On Friday last the scholarships and prizes gained during the session by students in the Faculties of Arts, Science, and Law were distributed at the Owens College. The Dalton Senior Mathematical Scholarship was gained by J. P. Whitney; the Dalton Junior Mathematical Scholarship by J. D. Pennington; the Dalton Chemical Scholarship by J. K. Crow; the Platt Physiological Scholarship by L. Larmuth. Mr. Crow presented a research upon the "Hypovanadous Compounds," and Mr. Larmuth a research upon the "Physiological Action of certain Vanadium Compounds." The number of students in the various departments of the College during the session just closed has been—Arts, Science, and Law, 415; Medicine, 175; Evening Classes, 900; making a total—allowing for double entries—of 1,450, being an increase of seventy on the number registered during the session of 1875-76.

LEEDS.—On Saturday the prizes and certificates awarded to the students at the termination of the third session of the Yorkshire College of Science were distributed by Lord Frederick C. Cavendish, the President of the College. Thoroughly gratifying reports of progress were made by all the professors. Not only has a site been obtained for the erection of permanent buildings, but an architect has been appointed to prepare plans and superintend the erection of the buildings. The first step has been taken to provide what we have all along advocated, a complete curriculum in literature as well as in science, by the appointment of Mr. Marshall as classical professor, and it is hoped that in a very short time a professor of modern literature will also be added to the staff. Liberal contributions have already been made towards the great expenses required to start the institution, and the University Extension Committee have handed over the whole of the funds of which they had been made administrators in connection with Leeds. Still to attain anything like efficiency the sum already obtained must be doubled. It is the people of Yorkshire who will mainly benefit by this new institution, and we hope it will not be difficult to convince them that it is both their interest and their duty to provide the greater portion of the funds required.

DURHAM.—At a recent Convocation the following degrees and licences were conferred in connection with the University:—B.Sc.: John Thomas Dunn, Mather Scholar. Associates in Physical Science: Edwin Cooke, John Richard Hutchinson Williamson.

PARIS.—The reconstruction of Charlemagne College, one of the most celebrated national colleges in Paris, has just been finished. The fitting-up of the buildings has begun, and they will be ready by October next. This college was established after the Revolution in the Hotel d'Anville, rue St. Antoine, which had been purchased from Anne de Montmorency by the Cardinal of Bourbon, and bequeathed by him to the Jesuits, then in hostility with the University.

A large number of houses having been pulled down in the Quartier Latin to make room for the Boulevard St. Germain, the works for the enlargement of the School of Medicine have been begun, and will be completed before the Exhibition. The expense will be 2,838,000 fr.

NOTES

THE varied and cultured tastes of the Emperor of Brazil are unusual even among private individuals, and probably without a parallel among his own limited class; his activity and eagerness for knowledge are astonishing. While in Paris, as we stated at the time, he was present at almost every scientific meeting of any importance, and in London this interest in science manifests itself quite as strongly. He has attended every meeting of the Royal Society since his arrival, was present at Mr. A. R. Wallace's lecture, carefully inspected the Science School at South Kensington, called the other day on Mr. Crookes, visited Dr. Siemens on Tuesday and Mr. Spottiswoode on Wednesday, and indeed has conversed with almost every man of science in London who has been doing any original work during the past few years. These visits are not mere formalities, for the Emperor is not satisfied until he masters whatever new research is submitted to him. On Tuesday he was made an honorary member of the Anthropological Institute and of the Royal Historical Society. Were the Emperor to stay here for some time we believe his presence would have a distinct influence on the public recognition of science; and if there were any one in this country in a similar station who took an equally real interest in science, we believe it would be all the better.

UNDER the auspices of the Sanitary Institute, Dr. Richardson, F.R.S., will deliver a lecture at the Royal Institution, Albemarle Street, on Thursday next, at 4 P.M., "On the Future of Sanitary Science in relation to Political, Medical, and Social Progress." We hope to give a verbatim report of this lecture in next week's number.

THE last meeting of the Royal Society previous to the recess was held last Thursday.

WE regret to see that Poggendorff's name has been entirely suppressed in the title-page of the new volume of the *Annalen*. The journal now edited by Borchardt still bears Crelle's name, and our *Philosophical Magazine* still keeps the names of Tilloch, Nicholson, and Thomson on its title-page. A similar allusion to the man who has made the *Annalen* what they are, would have been a better tribute to his memory than the short account of his life which closes what we must now call the last volume of *Poggendorff's Annalen*.

THE twenty-sixth meeting of the American Association for the Advancement of Science will be held at Nashville, Tennessee, commencing August 29, 1877. The president at this meeting will be Prof. Simon Newcomb; the permanent secretary is Prof. F. W. Putnam.

THE Geologists' Association have arranged for an excursion into Derbyshire on Monday, July 23 and five following days, under the direction of the Rev. J. M. Mello, Prof. Boyd Dawkins, and Mr. Rooke Pennington.

THE Select Committee to which the Ancient Monuments' Bill was referred met on Monday, when Sir John Lubbock was chosen chairman. The Committee meets again on Monday next, when evidence will be taken.

AT the meeting of the Royal Geographical Society on Monday, the last of the three lectures on scientific geography arranged for this session was given by Mr. A. R. Wallace, "On the Comparative Antiquity of the Continents." The object of the lecture was to establish the comparative antiquity of continents by an examination of the living and extinct animals found in each, and the lecturer came to the general conclusion that the main divisions of the earth had been nearly the same from the earliest period. The Emperor of Brazil was present during the lecture.

IN our report of the Anniversary Meeting of the Geographical Society it was stated that the Society contemplated organising an African Exploration Fund. The Society, it is known, has taken no share in the International African Association founded by the King of the Belgians; while doing everything to forward the views of that association, it seems to be of opinion that England ought to carry out African exploration independently. The Prince of Wales has become patron of the African Fund, and a special committee has been appointed, with the president of the society as chairman, the society having given a special donation of 500*l*. A map accompanying the programme of the scheme shows how large an area has been explored by British travellers, and several routes in Eastern Africa are suggested for exploration or careful examination. A comparison has been made of the length of each journey in Africa in a few recent instances, with the cost of making it. It appears that the total expense of despatching a well-equipped exploratory expedition from England may be roughly reckoned at the rate of 1*l*. 10*s*. for each geographical mile of country travelled over in Africa, supposing the expedition to return to the place whence it set out. In through journeys the rate is in many cases nearly twice as great. The aggregate length of the seven specified routes is about 7,700 geographical miles; consequently, the total cost of the proposed explorations, at the above rate, would amount to about 11,550*l*. No doubt many besides fellows of the society will be willing to help forward this new scheme. In connection with this we may here state that the International African Commission has concluded its labours. It has decided that the organisation of stations in Africa belongs to the Executive Committee. The principal object of these stations will be the suppression of the slave trade. It has also been decided that an expedition shall leave Zanzibar in the direction of Lake Tanganyika. The King of the Belgians has been re-elected president of the Commission.

Trübner, of Strassburg, publishes this month the first number of a new *Zeitschrift für physiologische Chemie*, edited by Prof. Hoppe-Seyler, of Strassburg and other eminent German chemists. The purpose of the journal is to keep together such original papers in physiological chemistry as are now scattered over various chemical, physiological, and medical journals. The new *Zeitschrift* will be published every two months.

IT is stated that in a field near Cologne the Colorado potato beetle has been found in every stage of development.

IN connection with the agitation in favour of planting the streets and squares of Manchester with trees, and protecting the suburban vegetation, which is being carried on by the Field Naturalists and Archæologists' Society of that city, a paper by Mr. R. H. Alcock, F.L.S., containing some curious information, was read at the last meeting of the Society. Mr. Alcock has experimented for the last twenty-five years in planting trees in the vicinity of his mill, situated in Bury, a smoky manufacturing town, a few miles from Manchester. He finds that the plane (*Platanus orientalis*), which is so successful in London, will not grow at all in Lancashire smoke even with careful culture. But on the other hand he has been very successful with the beech, sycamore, birch, wych elm, and Turkey oak. The lime, however, is the tree chiefly recommended: indeed, Mr. Alcock says of it that he is absolutely certain it will grow well in the Manchester thoroughfares if properly planted. If the Manchester people are enabled to walk *unter den Linden*, they will have reason to thank the Society which is making such commendable efforts to solve the problem in question.

IT is just 140 years since the National Library of Paris was made public. The area of the building has been enlarged more than twenty times since that, and a scheme is now being planned for isolating the building from every other house.

AN important French work has just appeared at Geneva—"Le Massif du Mont Blanc. Étude sur sa Constitution géodésique et géologique, sur ses Transformations et sur l'état ancien et moderne de ses Glaciers," by E. Viollet Le Duc, with 112 illustrations, and a map on the scale of 1 : 40,000. The work is the result of seven years' exploration, during which the author has set himself to map and describe with all possible accuracy, the characters of the rocks and of the soil, the successive beds of glaciers, the positions of moraines, the forms of the *cônes de déjection*, as well as the general aspect of this great upheaval. The map, based on the former maps of Capt. Mieulet, on the well-known relief of Mont Blanc constructed by Bardin, on the surveys of Forbes, on the work of Alph. Favre, and on careful surveys by the author himself, is indeed a remarkable work, scientifically and artistically. After many attempts the author has given up the idea of representing the relief by level curves, and has returned to the old graphic system under a light corresponding to that of the sun about 10 o'clock on a summer morning. In this way the relief of the locality is so perfectly represented on the map as really to deceive the eye. The geological description deserves the attention of all geologists.

MR. E. G. RAVENSTEIN, F.R.G.S., read an elaborate paper at the Statistical Society on Tuesday evening last week, on the populations of Russia and Turkey. The former of these Empires has 84,584,482 inhabitants, the latter only 25,986,868, or, including Egypt, Tripoli, and Tunis, 43,408,900. The population of Roumania is 4,850,000, of Servia 1,352,500. The population of Russia increases at the rate of 1·1 per cent. per annum, the increase amongst the Jews being at least double what it is amongst the Christians. With respect to Turkey there exist no data for calculating the increase, though it is most probable that the dominant race does not increase at all, a fact accounted for by vicious practices, and by the sacrifices demanded from it for the defence of the empire. Some curious facts were commented with respect to the proportions between males and females. Throughout Asiatic Russia and in a considerable portion of European Russia the male sex preponderates. The same fact has been noted in Roumania, in Greece, and in other parts of Europe. The author thus summed up the results of his investigations:—In the Russian Empire there are 100 Russians to every 50 members of other nationalities, and 100 Christians to every 16 Mohammedans and Pagans. In Turkey, on the other hand, 100 Turks have opposed to them 197 members of other nations and 100 Mohammedans, 47 Christians.

MR. STANFORD has just published sheet No. 1 of a large-scale map of the seat of war in Europe. It exhibits with great minuteness the region on both sides of the Danube where operations are being at present carried on, and extends southwards as far as the latitude of Philipopolis. It is admirably executed, and will enable a reader to follow the movements of the belligerents with complete satisfaction. Mr. Stanford also publishes a bird's-eye view, by Maclure and Macdonald, of the seat of war in Asia and Europe from Kurdistan, much better executed than the generality of similar maps.

FURTHER details appear in the American papers of the recent destructive earthquake and wave on the west coast of South America. A Lima correspondent states that at about 8·30 on the night of May 9, a severe earthquake shock, lasting from four to five minutes, moved the entire southern coast, even reaching down as far as Antofagasta. The first shock was succeeded by several others of less intensity, and the sea, receding from the shore, seemed to concentrate its strength for the fearful and repeated attacks it made upon the land. It left Callao and proceeded southward. At Mollendo the railway was torn up by the sea for a distance of 300 feet, since repaired; and a violent hurricane afterwards set in from the south, preventing the approach of all vessels, and unroofing the houses of the town. At Arica the shocks were very numerous, and caused immense damage in the town, the people flying to the Morro for safety. The sea was suddenly perceived to recede from the beach, and a wave from ten feet to fifteen feet in height rolled in upon the shore, carrying before it all that it met. Eight times was repeated this assault of the ocean. Iquique is in ruins. The movement was experienced there at the same time, and with the same force. Its duration was exactly four minutes and twenty seconds. It proceeded from the south-east, directly from the direction of the Ilaga. The town of Tarapatt, twenty-five leagues inland, and the villages of Rica, Matella, and Canchones were more or less damaged. The shock of earthquake was especially severe at Chanavaya. In some spots the earth opened in crevices of fifteen metres in depth, and the whole surface of the ground was changed. At least 200 persons were killed. At Antofagasta the atmosphere was illuminated by a red glare, supposed to proceed from the volcano of San Pedro de Atacama, a few leagues in the interior. The sea completely swept the business portion of the town during four hours. At Huanillion the wave which succeeded the earthquake was nearly sixty feet in height. Mexillones was visited by a tidal-wave sixty-five feet in height. Two-thirds of the town were completely obliterated In connection with the so-called "Tidal Wave" of the Pacific, Mr. Manley Hopkins writes to yesterday's *Times*:—About the 1st of May last the great crater of Kilauea, on the flank of Mauna-Loa, had become active. On the 4th rather severe shocks of earthquake were felt at the Volcano House. At 3 P.M. that day a jet of lava was thrown up to the height of about 100 feet, and afterwards other jets, to the number of fifty, perhaps, were in operation. Subsequently jets of steam issued along the line formed by a fissure four miles in length, down the mountain side. On the 5th, an observing party finding the disturbance lessened, descended into the vast crater. On the plain which forms the floor of the crater a mamelon had been thrown up 1,400 feet in diameter and 700 feet in height. Fire and scoria spouted up in various places. Pele's hair, vitreous filaments formed in the volcano, abounded. Things returned to a quiescent state. Between 4 and 5 A.M. of the 10th an oscillation of the sea was observed at Hilo, on the east coast of the great southern island of Hawaii. At a quarter before 5 the great "earthquake wave" struck the village. The greatest difference between the crest and the trough of the wave was here, and it measured 36 feet. On the opposite side of the island, in Kealakekua Bay, where Cook died, the measurement was 30 feet. In other localities the difference varied down to 3 feet. The regurgitations of the sea were violent and complex, and continued through the day. The great wave seems to have struck all the islands at the same time without reference to position. The height of the waves was nowhere so great as at Hilo. In 1868 a great earthquake wave destroyed Arequipa and Arica; 30,000 lives were lost at that time. Allowing five hours for the difference of longitude between those ill-fated towns and Honolulu, and supposing that the centre of the seismic action was rightly placed, the wave on that occasion, 1868, was calculated to have travelled the 5,000 miles between Arica and Honolulu in twelve hours, or at the rate of 446 miles an hour.

THE shock of an earthquake visited the district between Aix-la-Chapelle and Cologne at about 9 A.M. on Sunday. The movement was from south-west to north-east, and lasted from three to fifteen seconds. The vibration resembled that caused by a heavy goods train. The *Cologne Gazette* remarks that the last earthquake in the Rhine district occurred on November 17, 1868, two days after a considerable eruption from Vesuvius had commenced

AT a recent meeting of the Christchurch (N.Z.) Philosophical Institution, Dr. Haast gave an account of the discovery of remarkable ancient rock paintings in the Weka Pass Ranges. Some of them are fifteen feet long; they represent animals of foreign countries, weapons and dresses of semi-civilised people; underneath are characters like those of the Tamil language, and those on the ancient hill found in the North Island.

THE great Moscow Polytechnic Museum was opened on June 12 by an extraordinary meeting of the Society of Friends of Natural Science.

THE Irkutsk newspaper *Siberia* announces that on April 28, at 9.30 A.M., an earthquake was felt at Irkutsk. The shock was very short and rather strong.

THE second fascicule of the sixth volume of the *Memoirs* of the Kazan Society of Naturalists contains the annual report of the Society. The most important work done by the Society was a geological exploration of the permian and carboniferous deposits along the banks of the Volga, between Stavropol and Syzran, by M. Stuckenberg, and of the banks of the Kama in the Vyatka government, by M. Zaytseff.

THE additions to the Zoological Society's Gardens during the past week include a Patas Monkey (*Cercopithecus ruber*) from West Africa, presented by Mr. Edward Poulson; a Yellow Baboon (*Cynocephalus babouin*) from West Africa, presented by Mr. H. E. Walters; a Purple Kaleege (*Euplocamus horsfieldi*) from the North-west Himalayas, presented by Mr. John Ditmas; an Imperial Eagle (*Aquila imperialis*), European, a Barrabands Parrakeet (*Polytelis barrabandi*) from New South Wales, deposited; seven Spotted-billed Ducks (*Anas pœcilorhyncha*), seven Chilian Pintails (*Dafila spinicauda*), eight Summer Ducks (*Aix sponsa*), two Bronze-winged Pigeons (*Phaps chalcoptera*), a Geoffroy's Dove (*Peristera geoffroii*), bred in the Gardens; a Hippopotamus (*Hippopotamus amphibius*), born in Holland, purchased.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 31.—"The Physical Properties of Homologues and Isomers," by Frederick D. Brown, B.Sc.

When we attempt to compare the physical properties of a series of compounds presenting very similar chemical properties, we find, that although our knowledge regarding one or two members of the series is tolerably complete, it is very restricted concerning the others.

Among the alcohols of the $C_nH_{2n+1}OH$ series, for example, there are two—methyl and ethyl alcohols—with whose physical properties we are well acquainted, but when we pass to the other members of this series we find, that with the exception of numerous determinations of density and boiling-point, experiments have been limited to the measurements of expansion which have been carried out by Kopp, Pierre and Puchot, and others.

In order to supply this want, I have undertaken a series of experiments, the first of which are here noticed.

The density, expansion, and vapour-tension of propyl and isopropyl iodides have been measured with the greatest care; the chief difficulty to be overcome being the impurity of the liquids themselves, more than a kilogramme of each was specially prepared and dried by means of phosphoric anhydride; it was then submitted to fractional distillation, about 500 grammes of perfectly pure iodide being thus obtained; this was again distilled and collected in about four portions, each of which formed the subject of a series of experiments. The results obtained with all these portions agreed most satisfactorily, showing that when the substance is prepared with care, the error due to impurity is well nigh obviated.

The following table gives the results in such a form as to show that when the tensions of the saturated vapours of both iodides are equal, the densities and consequently the molecular volumes are unequal.

Vapour-tension in millims.	Boiling-point of normal propyl iodide.	Boiling-point of isopropyl iodide.	Density of normal propyl iodide.	Density of isopropyl iodide.	Difference between densities.
200	62°37	50°50	1·66704	1·64590	0·02114
300	73·51	61·33	1·64493	1·62359	0·02134
400	81·95	69·70	1·62808	1·60646	0·02162
500	88·84	76·44	1·61446	1·59246	0·02200
600	94·70	82·11	1·60250	1·58068	0·02182
700	99·83	87·13	1·59221	1·57035	0·02186
760	102·63	89·86	1·58670	1·56497	0·02196

It will be seen that this is in contradiction to Kopp's law, but that it is in accordance with the modern dynamical hypotheses on the constitution of matter, since the instability of the secondary iodide may be due to the greater *vis viva* of its molecules, which in turn would cause an increase of the mean distance between the molecules.

I may here mention that I have made a very complete series of experiments on the vapour-tension of normal propyl alcohol. The curve representing these observations intersects that which expresses the tensions of normal propyl iodide, so that whereas at 760 millims. the iodide boils at 102°·5 and the alcohol at 97°·3, at 370 millims. they boil at the same temperature, viz., 79°·5, and at 120 millims. the boiling-point of the iodide is only 49°·5, whilst that of the alcohol is 56°.

This fact, which probably arises from the much greater latent heat of propyl alcohol, obviously renders useless all attempts to derive the boiling-points from the constitution of chemical compounds, so long as the boiling-points at the ordinary pressure of the atmosphere alone are taken into account.

Mathematical Society, June 14.—Lord Rayleigh, F.R.S., president, in the chair.—Prof. Crofton, F.R.S., proved some geometrical theorems relating to mean values. These theorems were chiefly interesting as examples of the employment of the theory of probability to establish mathematical results; they were of a kindred nature with theorems given in the *Phil. Trans.*, 1868, p. 185, and in Williamson's "Integral Calculus," second edition, p. 329. Mr. Merrifield made a few remarks on the communication.—Prof. Clifford, F.R.S., read a paper on the canonical form and dissection of a Riemann's surface. The object of the paper is to assist students of the theory of complex functions by proving the chief propositions about Riemann's surfaces in a concise and elementary manner. To this end certain results of Puiseux's were assumed at the outset. Prof. Smith in making remarks on the paper expressed his indebtedness to the author in having cleared up a difficulty which presents itself in Lüroth's paper on the subject.—Prof. H. J. S. Smith, F.R.S., gave a short account of a further communication upon Eisenstein's theorem.—Mr. Tucker communicated a paper by Mr. J. C. Malet entitled, "Proof that every Algebraic Equation has a Root."—The Society's next meeting will be held on the second Thursday in November.

Royal Astronomical Society, June 8.—Dr. Huggins, F.R.S., in the chair.—Some tables for facilitating the computation of star constants were presented by Mr. Stone.—Mr. Marth explained diagrams referring to conjunctions of Saturn and Mars between July and November next—being a triple conjunction.—Dr. Royston Pigott described a method of collimating reversible instruments by which the error could easily be determined within 2″. Mr. Dunkin intimated that he would be greatly disappointed to find his collimation 0″·25 out.—Mr. Gill recounted some of the troubles that beset people who go after parallax, and described some methods of getting rid of systematic errors.—The president in the name of the meeting said "Good-bye" to Mr. Gill on the eve of his departure for the Island of Ascension.—At 9 P.M. the proceedings were stopped by the president to leave time for the special meeting called to consider a proposed alteration in the bye-laws.

PARIS

Academy of Sciences, June 18.—M. Peligot in the chair.—The following papers were read:—On the notation of Berzelius, by M. Berthelot.—Some observations on the mechanism of chemical reactions, by M. Berthelot. The new facts observed relate to direct oxidation of haloid salts, and of sulphurous and arsenious acids.—On the order of appearance of the first vessels in the aërial organs of some Primula, by M. Trécul.—On the crystalline form and the optical properties of proto-iodide of mercury, by M. Des Cloizeaux. The crystals generally occur in the form of thin, flexible, weakly dichroïc plates, of the quadratic system, but liable to be mistaken for a clinorhombic combination. Across the planes of cleavage they give strong double refraction, with positive axis. The salt is completely isomorphous with calomel (or the protochloride); and it is imperfectly so with red bi-iodide of mercury, which, however, has a *negative* axis. M. Berthelot, in view of such facts, remarked on the uncertainty they throw on the employment of isomorphism as a method for determining the number of atoms contained in a compound, and consequently the absolute value of the atomic weights.—Reply to the observations of M. Mouchez, by M. Villarceau.—On M. Villarceau's *Nouveau Navigation*, by M. Mouchez.—On the interior sea of the Algerian Sahara, by M. Favé. The slope at the borders of the lake, he points out, would be very pronounced.—Theory for finding the number of variants and contravariants of given order and degree linearly independent of any system of simultaneous forms containing any number of variables (continued), by Mr. Sylvester.—On the present state of the solar atmosphere; letter from P. Secchi. In presenting a *résumé* of the spots and protuberances of 1876, he gives his reasons for thinking the sun in a state of *relative* (not *absolute*) calm. M. Janssen's view that there is rather a tendency to speedy dissolution of spots than a state of (even relative) calm, implies, he thinks, the false idea that spots can be maintained for long without the continuance of eruption. Their short duration indicates a short time of eruption, therefore weak solar activity. Spots continue because the dissolved matter is replaced by freshly erupted matter. We have no proof, either, that dissolution is more rapid at the periods of minimum. There are now signs of re-awakening activity.—On electro-magnets with rundles of iron, by M. Du Moncel. He is led to study these again by experiments of M. Fridblatt and M. Jablochkoff. The lateral action of the magnetising currents on the rundles is limited, he thinks, to a simple dynamical reaction between parallel currents, which may, with very strong currents, make plates of iron adhere strongly to the cheeks of the spiral, but which does not develop *exteriorly* on these plates well-marked magnetic polarities. This latter only occurs where the plates are so small that the spirals act on them by enveloping them like a core.—On the use of sulpho-carbonates and sulphide of carbon in treatment of the vine, by M. Marès.—On a temporary affection of sight, by M. Pierre. Reading, one day, after having had brain fever, a glazed volume, he found the characters apparently more distant than the paper (about 4 mm.); and the exercise was very fatiguing. In the next eight or ten days the characters seemed gradually to come nearer to the surface.—Historical remarks on the theory of motion of one or several constant or variable forms in an incompressible fluid, &c. (continued), by M. Bjerknes.—Determination of groups formed of a finite number of linear substitutions, by M. Jordan.—On the metallic solar eruptions observed at Palermo from 1871 till April, 1877, by M. Tacchini. In 1871 the zone of eruptions was confined between + 70° and − 40°; in 1876 it extended only between zero and − 21°; and in the first four months of 1877 there has only been one very small eruption.—On a new general method of synthesis of hydrocarbons, acetones, &c., by MM. Friedel and Crafts.—Reducing action of phosphorus on sulphate of copper; phosphides of copper, by M. Sidot.—Chemical researches on crystallised carbonate of lead formed on objects found at Pompeii, by M. de Luca.—Observations on some xanthates; separation of cobalt and nickel, by M. Phipson.—Researches on tetrachloride of carbon and its employment as an anæsthetic, by M. Morel. He was led to this application of it by the similarity of its formula (C_2Cl_4) to that of chloroform (C_2HCl_3). It is found a perfect anæsthetic and more powerful than chloroform, but quite capable of being regulated. The periods of insensibility and collapse are identical with those of chloroform; that of excitation is more pronounced. A mode of preparing the substance is described.—Observation of a bolide at Clermont-Ferrand on June 14, 1877, by M. Grerey. The head was about five to six minutes apparent diameter; the light was bright and flashing, with slight reddish and bluish gleams. No sound was perceived.—On a solar halo, by M. Vinot.

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