THURSDAY, AUGUST 31, 1899.

PLANTS AND THEIR ENVIRONMENT.

Les Végétaux et les Milieux Cosmiques (Adaptation–Evolution). Par J. Constantin. Pp. 292. Avec 171 gravures dans le text. (Paris: Félix Alcan, 1898.)

THIS little book has some admirable points which can be urged in its favour, and it also exhibits lacunæ which are a source of irritation to the reader. Chief amongst its more obvious defects is the entire lack of reference to literature. In a book of this sort such references are particularly desirable, as it will be read by many who may have no special first-hand acquaintance with the sources whence M. Constantin draws his facts.

The book is well conceived and clearly written, though of course it makes no claims to be considered as an exhaustive treatise.

The various kinds of surroundings in which different plants live, and the nature of the corresponding response on the part of the plant organism forms the main thesis of the book. An example will serve to illustrate the author's method.

The cold temperate climate on the whole tends to favour the production of dwarf plants, whereas the colder seas, as is well known, are the home of the largest algæ. Ultimately both of these apparently contradictory effects are to be explained on nutritional grounds, the short period of terrestrial vegetation, during which alone assimilation can proceed, is to be contrasted with the more equable temperature of the sea, and especially with the fact that nutrition is favoured, in the case of aquatics, by lower temperatures, since gases are more soluble, and hence more abundantly at the disposal of the organism, than would be the case in warmer water.

Similarly, the effects of light, gravity and aquatic surroundings upon the structure and form of plants are discussed, and the reader will find much to interest him in the pages which deal with these topics. At the same time it must be confessed that the treatment strikes one as somewhat superficial at times, especially when the author wanders into the paths of theoretical interpretation.

M. Constantin shares the belief, emphatically held by some German botanists, in the direct influence of the environment not only as modifying the form in the individual but also as impressing, without the aid of natural selection, that form on the species as part of its inherited stock; and one chapter is devoted to an attempt to establish the thesis that acquired characters are inherited. As usual, however, in such cases, the meaning of "acquired characters" is not rigidly defined, nor separated from latent possibilities in the organism which the environment is able to emphasise simply by providing that stimulus which ensures their positive appearance.

Some of these variations, responsive to the external requirements, are certainly very difficult of explanation on the doctrine of selection, but the opponents of this theory sometimes seem to overlook the fact that, in the first place, it is not in the least necessary to assume that variations will be *slight;* they are often, on the contrary, in the case of specially plastic individuals, very extensive when these are subjected to a change of environment. And, in the second place, it is not necessary to suppose that any given species, and far less any individual, will vary equally in different directions round its average or mean. A very slight acquaintance with horticultural operations is enough to convince any one that certain races are specially plastic as regards one organ, whilst in others modification is most easily provoked in a different one. And selection, acting as it essentially does by eliminating those which conform less readily to the requirements of the environment, can hardly be dismissed, as M. Constantin dismisses it, as of relatively small importance in the evolution of species. But the difficulty really does exist if we only assume the possibility of slight variation ranged equally round a mean. In this case, of course, it is difficult (apart from isolation, physical or physiological) to see how a new species could be evolved at all when the chances of intercrossing are considered. But, as has been indicated, such a restriction is entirely gratuitous, and, furthermore, is contradicted by experience.

The facts adduced by the author, drawn from the studies of Schübeler and Bonnier, on the sudden evolution of spring- from autumn-wheat, hardly seem to help the case of the inheritable influence of the surroundings at all. For it is conceded that if autumn-wheat be sown in spring, a large percentage of the plants do not ripen fruit. Those that do succeed may, however, be supposed so to develop because their latent possibilities in this direction were greater than those possessed by their unsuccessful comrades. Next year, of course, the sowings obtained from the survivors will possess the same character for speedy growth and early maturity in a far larger average number, since the parents *all* had clearly a trend in the required direction. But it is misleading to speak of this as an inherited effect due to the impressed action of the environment, *i.e.* the inheritance of an acquired character, for it is clearly nothing more than the encouragement of possibilities which were latent before, and, but for the changed conditions, might never have been raised to the position of criteria of existence at all.

But this confusion between an outside moulding influence (*e.g.* mutilation) and the *evoking* from the plastic organism of a suitable response to the environment imposed by new conditions, is very wide-spread; and although the difference is in reality one altogether of kind, it is often in practice overlooked.

A good summary is given of some of the interesting results obtained by French investigators on crossing races and species, but some of the other chapters strike one as rather weak, *e.g.* those dealing with the action of gravity on plants. The account of aquatic plants is also somewhat disappointing, especially as the author has himself worked in this branch of the subject.

Nevertheless, the book is worth reading, bringing together as it does a considerable body of scattered facts which are lucidly arranged within a moderate number of pages.

J. B. F.

T

THE NEWTONIAN POTENTIAL.

Théorie du Potentiel Newtonien. By H. Poincaré. Pp. 366. (Paris: Georges Carré and C. Naud, 1899.)

THE course of lectures given by Prof. Poincaré at the Sorbonne during the session of 1894-5 has, under the editorship of Dr. Édouard Leroy and M. Georges Vincent, assumed the form of a text-book on attractions and the theory of the potential.

The subject-matter naturally falls into two sections, one referring to special properties of potentials of linear, superficial and volume distributions, and the other dealing with Dirichlet's problem and its solution. It is rather a pity that this division was not adhered to in the arrangement of the text. Chapter vi., dealing with the potentials of magnetic shells, is quite out of place in the middle of Dirichlet's problem, and should logically have preceded the two previous chapters.

In opening what we have regarded as the first subject, M. Poincaré introduces concurrently with the Newtonian potential the logarithmic potential corresponding to the law of the inverse distance, which represents the two-dimensional potential of infinite cylindric distributions. The first chapter, which includes calculations of the potentials of rods, cylinders, spheres, and other simple forms, deals with potentials of bodies at external points. It contains a brief account of Legendre's coefficients. In passing to the interior of the attracting mass in Chapter ii., the question of the convergency of the integrals representing the potential and its derivatives naturally necessitates a brief digression on convergent integrals in general. Chapter iii. deals with potentials of linear and superficial distributions of matter, and naturally leads on to the misplaced Chapter vi., which treats at considerable length of "double layers" (*doubles couches*)—in other words, magnetic shells.

The second subject opens in Chapter v., where Dirichlet's problem is stated, the principal properties of Green's function are proved, and the equivalence of the two problems is established. In the next chapter Prof. Poincaré gives the solutions of Dirichlet's problem for a circle and a sphere, and deals with the properties of conjugate functions and conformal representation in two dimensions. Chapter vii. treats of the method of exhaustion (*balayage*), and the remaining eighty pages contain a fairly detailed account of Neumann's method and its extensions.

Lecture notes are rather apt to be deficient in explanation on points which have either been taken for granted by those who transcribed them, or have been incidentally explained in a conversational way by the lecturer. Any one not starting with a previous knowledge of the definition of the potential would hardly find M. Poincaré's opening very clear. In first "letting" $f_1'(r_1)$ be the attraction at distance r_1 and afterwards defining the potential as $-\Sigma f(r)$ it ought to be explicitly stated that $f_1'(r_1)$ is the derived function of the subsequently introduced function $f_1(r_1)$. Moreover, why should the constant of integration in $f_1(r_1)$ be taken as zero in the Newtonian and as $-m \log r_0$ in the logarithmic potential? A few additional words of explanation in such cases would often save readers from wasting time over unnecessary difficulties.

There are many problems which, although belonging to the subject proper of attractions and potential, are not included in the present volume. The potentials of ellipsoids are untouched, Lamé's ellipsoidal harmonics being dismissed with a mere reference. Then, again more might have been said about spherical harmonics. It will be seen, however, that M. Poincaré's lectures have reference to the general theory of the potential rather than to special problems, which find appropriate treatment elsewhere.

As an introduction to this theory dealing at some length with Dirichlet's and Neumann's developments, M. Poincaré's volume bids fair to be a useful addition to the library of college lecturers as well as of the more advanced class of mathematical students. G. H. B.

OUR BOOK SHELF.

Faune de France—Mammifères. By A. Aclogue. Pp. 84; Figs. 9. (Paris: Baillière.)

As compared with that of the British Isles, the mammalian fauna of France is much more extensive, comprising a number of Mediterranean types quite unknown among the former. It is therefore, altogether apart from patriotic considerations, well worthy of being separately monographed. This task has been undertaken by the author of the present little volume; and although in the main the very condensed descriptions given appear satisfactory so far as they go, we cannot but regret that the work was not written more on the lines of Bell's "British Quadrupeds."

The volume commences with an illustrated dissertation on the characteristics of, first, the Vertebrata and then of mammals; and in this part we notice that on p. 21 the author figures the skull of a bat as that of a mole, and also one of a porcupine as that of a second representative of the insectivorous order.

The illustrations are, indeed, very discreditable, the only passable ones being those borrowed from other works. In these days of cheap "process-blocks" it does seem inexcusable to issue caricatures like those in the present volume. The type, too, is extremely small.

The descriptions of the genera and species, although, as already said, very short, are sufficient to admit of their identification. Some of the terms used, such as (p. 73) "*Bosidi*"—the equivalent of *Bovidae*—sound, however, somewhat strange to English ears; and it may be added that the nomenclature generally is by no means altogether up to date. Moreover, even if it be considered advisable in a work of this nature to introduce the ordinary indigenous domesticated animals, such as sheep and oxen, there seems little to justify the inclusion of such a palpable foreigner as the guinea-pig.

The best we can say is to express the hope that the author may, before long, see his way to reissue what forms the rudiments of a very useful work on a scale more commensurate with the importance and interest of the subject. R. L.

Anatomical Diagrams for the use of Art Students. By James M. Dunlop. Pp. 72. (London: George Bell and Sons, 1899.)

As to how much or how little knowledge of anatomy the art student should possess is a matter on which opinion is very much divided. Your youthful impressionist is apt to sneer at anatomy; as a rule, his contempt for the subject is revealed in the construction of the forms he represents. On the other hand, the more serious-minded and studious of the artistic fraternity, those who, by hard work and diligent study, are laying the foundations upon

which a true impressionism can alone be based, have found and do find the study of anatomy a help in their work.

That such knowledge may be abused is not surprising; the example of the unfortunate Haydon might serve as a warning. Yet there are plenty of instances in modern work in which this knowledge is duly restrained. Leighton had a keen appreciation of anatomical detail, and his bronze of an Athlete struggling with a python is likely to outlive most, if not all, his pictorial efforts as a work of art.

Books on so-called artistic anatomy, written usually by surgeons and anatomists having little or no knowledge of the requirements of artists, have, as a rule, been prepared by "boiling down" the technical treatises supplied to medical students. It is to Dr. Paul Richer that we are indebted for having dealt with the subject in an appreciative spirit; he approaches it, not merely from the standpoint of the anatomist, but from that of the artist as well. His method is to represent the figure in action in different poses, and submit a chart explanatory of the various structures on which the surface contours depend, having first, of course, supplied his readers with such information regarding the bones and muscles as is necessary to enable them to understand and appreciate the diagrams. It would be difficult to over-estimate the value of his book; its cost, however, places it beyond the reach of most students.

When an art-master produces an atlas of anatomical diagrams, we naturally expect to have fresh light thrown on the subject, together with a keener appreciation of the requirements of art students. We are not inclined to be too exacting with regard to the anatomical details if only we can get some further insight into their application to the study of the human figure.

In an interesting introduction to the present volume, Prof. Cleland, whose artistic sympathies are well known, makes use of the statement that the work occupies "ground which has not hitherto been taken up." With this opinion we cannot agree; for, as a matter of fact, the bulk of the illustrations in this atlas are reproductions, somewhat diagrammatically treated, of tracings or combined tracings of Richer's drawings. To these the author has had no hesitation in affixing his name without, so far as we can ascertain, once mentioning the source from which his figures are derived. The only features in the book which display any originality are the plates in which those parts of the skeleton having a direct relation to the surface contours are blocked in in distinctive colours. The absence of explanatory text, as well as the lack of reference to the contours of the figure in action, seem to us to minimise its value as a text-book to be placed in the hands of students. As diagrammatic reproductions of Richer's figures, the plates in this atlas may not be without value. We confess, however, to a preference for the originals.

Chemistry for Continuation Schools. By R. L. Taylor. Pp. 52. (Manchester: Thomas Wyatt, 1899.)

THIS little book, like many others which have appeared during the past few years, should assist the progress of rational methods of teaching elementary chemistry. It consists of a series of nearly a hundred simple experiments to be performed by or for pupils commencing the study of chemistry. The subjects illustrated by the experiments are elements and compounds, chemistry of the air, water, acids and alkalis, carbon and carbon dioxide. Pupils who perform the experiments will obtain a sound knowledge of the nature of chemical changes, and of the properties of some common substances.

Fig. 3, illustrating the preparation and collection of oxygen from potassium chlorate and manganese dioxide, shows a liquid in the flask instead of the oxygen mixture.

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 intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Blue Ray[1] of Sunrise over Mont Blanc.

LOOKING out at 5 o'clock this morning from a balcony of this hotel, 1545 metres above sea-level, and about 68 kilometres W. 18° S. from Mont Blanc, I had a magnificent view of Alpine ranges of Switzerland, Savoy, and Dauphiné; perfectly clear and sharp on the morning twilight sky. This promised me an opportunity for which I had been waiting five or six years; to see the earliest instantaneous light through very clear air, and find whether it was perceptibly blue. I therefore resolved to watch an hour till sunrise, and was amply rewarded by all the splendours I saw. Having only vague knowledge of the orientation of the hotel, I could not at first judge whereabouts the sun would rise; but in the course of half an hour rosy tints on each side of the place of strongest twilight showed me that it would be visible from the balcony; and I was helped to this conclusion by Haidinger's brushes when the illumination of the air at greater altitudes by a brilliant half-moon nearly overhead, was overpowered by sunlight streaming upwards from beyond the mountains. A little later, beams of sunlight and shadows of distant mountains converged clearly to a point deep under the very summit of Mont Blanc. In the course of five or ten minutes I was able to watch the point of convergence travelling obliquely upwards till in an instant I saw a blue light against the sky on the southern profile of Mont Blanc; which, in less than the one-twentieth of a second became dazzlingly white, like a brilliant electric arc-light. I had no dark glass at hand, so I could not any longer watch the rising sun.

KELVIN.

Hotel du Mont-Revard, above Aix-les-Bains,
August 27.

A Fold-Making Apparatus for Lecture Purposes.

I HAVE found the piece of apparatus which I am about to describe so effective for lecture experiments, that I venture to think that others engaged in geological teaching may be glad to possess details as to its construction and mode of operation.

The machine (Fig. 1) consists of two parallel wooden rollers, about 3 feet apart. Each is about 12 inches long and 4 inches

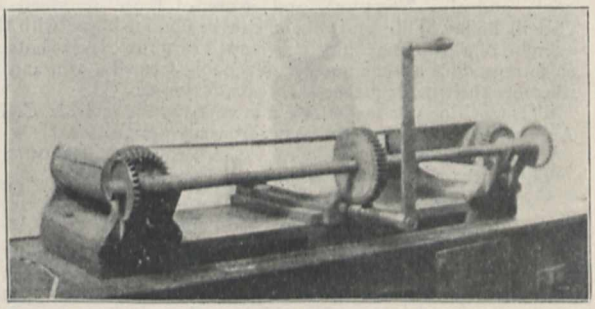


FIG. 1.

in diameter. A shaft at right angles to their length turns the two rollers in opposite directions by means of toothed bevel wheels, the shaft itself being driven by a worm wheel and worm, the latter being actuated directly by the handle. One turn of the handle only causes $\frac{1}{24}$ turn of the shaft and rollers, so that a very slow motion can be imparted to the latter. A sheet of

[1] The "Rayon Vert" of Jules Verne is the corresponding phenomenon at sunset; which I first saw about six years ago.

india-rubber about ½-inch thick, firmly attached by a slot and screwed bar to each roller, completes the arrangement.

The rollers being wound through about one entire revolution, and the india-rubber being thus stretched tight, layers of cloth, clay, paste or other giving material, are laid upon it. The handle is then turned in the reverse direction, and the india-rubber gradually released. Folds are in this way shown slowly growing—the broad elastic band simulating the contraction of a portion of the earth's crust. In Figs. 2 and 3, cloths are seen

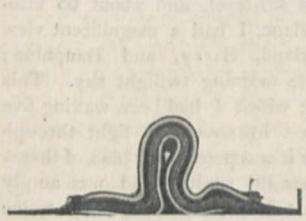


FIG. 2.

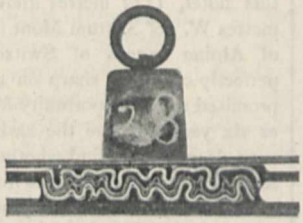


FIG. 3.

folded thus—first, without superincumbent weight, and second, with a weight of 30 lbs.

That the larger folds are those generated at the surface, and the smaller and more numerous those produced under pressure (*i.e.* at great depths), is here made evident.

By substituting blocks of stone or wood for ordinary weights above the cloths (Fig. 4) and repeating the experiment, some of the relations between folding and faulting are clearly shown.

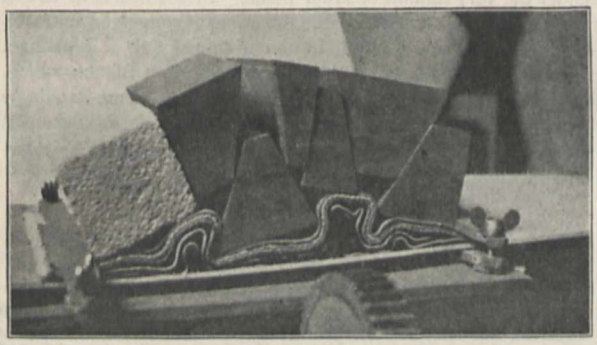


FIG. 4.

If clay be used instead of cloths, all the results of Favre's well-known experiments (*Arch. d. Sciences Phys. et Nat.*, 1878, and also NATURE), and many of those described by Cadell, Bailey Willis and others, can be obtained, and with the exercise of a little ingenuity it is easy to vary the experiments so as to reproduce a large number of the fold-forms known, and to illustrate their consequences—thrusts, faults, &c.

This machine was made for me in 1880 by the late Mr. C. D. Austen, of Newcastle-upon-Tyne, from my designs.

G. A. LEBOUR.

The Durham College of Science, Newcastle-upon-Tyne, August 18.

Scoring at Rifle Matches.

IN his letter to NATURE of August 17, Mr. Mallock appears to assume that there is such a thing as abstract "accuracy" in estimating the value of a marksman's score. The method in use at Bisley is, as I understand him, to be regarded as a rough approximation to the accurate method, whether the best available approximation or not. Is it not rather the case that the standard of accuracy is itself arbitrary, and what the authorities at Bisley have established is not an approximation to an ideal standard, but is to be regarded as a real standard of excellence?

In result Mr. Mallock's "accurate" method is this: in his notation any two scores for which $R^2+\rho^2$ is the same are of equal merit, or that one for which $R^2+\rho^2$ has the least value is the best score. Now, if "a" be the distance of any shot mark from the bull's-eye, n the number of shots, $R^2+\rho^2=\Sigma a^2/n$. Mr. Mallock's standard, then, is that the best score is that for which the sum of the squares of the distances from the bull's-eye is minimum. I see no reason why this method should be regarded as accurate *par excellence*, except the analogy of the method of least squares. But the analogy is misleading.

Where the method of least squares is applicable, the object is to find the most advantageous value of an unknown quantity to be deduced from a number of observations. An accurate value of the quantity does exist. And of two or more results deduced from the observations, that which is nearer to the accurate value is always better than one more remote, however near to the truth either may be.

In rifle shooting, on the other hand, there is generally some finite space—*e.g.* the port-hole of an enemy's ironclad, such that all shots which pass through it are of practically equal value, and all shots which do not pass through it are of little or no value.

This is much more accurately represented by the Bisley method than by the method which Mr. Mallock would substitute for it.

S. H. BURBURY.

THE only remark I should wish to make on Mr. Burbury's letter is that every shot on the target is truly the record of an observation, and that there is every reason to treat these records as far as is practicable by the methods which apply in obtaining the best means of a number of observations. Of course, it is only in the case of "centre of target" competitions the "$R^2+\rho^2$ a minimum" test applies. Prizes might well be given for close grouping, with a penalty depending on the mean distance of the group from the centre of the target.

August 22. A. MALLOCK.

Spectrum Series.

SIR NORMAN LOCKYER'S lectures on "Spectrum Series" seem to show very clearly the important fact that there is a close connection between the valency of an element and the lines in its spectrum.

The connection indicated is as follows:—

Nonvalent elements yield spectra with single lines.

Monovalents yield doubles.

Divalents yield triplets.

On turning to the list given in NATURE (vol. lx. p. 370), it will be seen that helium, by yielding doubles as well as singles, and cobalt, by yielding doubles only, are practically the only discordant cases in Sir Norman Lockyer's list, since aluminium and indium are trivalents, and their anomalous behaviour in yielding doubles only can perhaps be explained.

August 26. W. SEDGWICK.

Magnetic "Lines of Force."

IN some text-books and by some lecturers (*e.g.* Prof. A. Gray, as reported in NATURE of August 17, p. 379), the lines of magnetic force are said to be the curves along which iron filings are marshalled when sifted over a piece of card laid over a horizontally placed magnet.

Surely this is hardly correct. The true lines of magnetic force must be represented, like those of all other radiant forces, by radiating straight lines drawn through the points of action of the resultants of all the forces residing in the individual molecules of a given magnet (such points, though varying in position with the position of a magnetic body in the field, being often referred to as fixed "poles").

The symmetrical figures traced out by iron filings merely show, of course, the directions in which a line joining the poles of a very short magnet will lie in different parts of a magnetic field, under the influence of the true lines of force.

E. R. P.

August 29.

Critical Pressure.—A Suggested New Definition.

THE critical pressure of a substance is commonly defined as "the least pressure that will suffice to reduce that substance from the gaseous to the liquid state when at its critical temperature." But this definition contemplates the matter solely from the stand point of what occurs at the critical temperature, and I think it

would sometimes be an advantage to have one presenting a broader view and making no reference to any specific temperature, just as the ordinary definition of critical temperature makes no reference to any specific pressure.

Now, if in a *pv* diagram we draw the curve formed by the liquid and vapour lines, the indicator points corresponding to the "mixed state" (*i.e.* part vapour and part liquid, each more or less distinctly discernible) lie wholly within the region bounded by this curve and the axis of volume; also the ordinate of the highest point of this curve—where, of course, the tangent is horizontal—corresponds to the critical pressure, and the "critopiestic" or critical pressure line is the said horizontal tangent.

All horizontal lines below the critopiestic intersect the region corresponding to the "mixed state," while those above do not, thus showing that at pressures below the critical the substance changes from gas to liquid, or *vice-versa*, by the *ordinary* process of condensation or evaporation, *i.e.* by passage through the mixed state, while above that pressure this process does not take place, but the change occurs by continuous and imperceptible transition.

Of course all this accords with experiment, as is pointed out in several, though by no means all, the standard text-books. Thus on p. 123 of the new edition of Clerk Maxwell's "Theory of Heat," revised by Lord Rayleigh, we read:—"If we begin with carbonic acid gas at 50° F. we may first heat it till its temperature is above the critical, 88° F. We then gradually increase the pressure to, say, 100 atmospheres. During this process no sign of liquefaction occurs. *Finally we cool the substance still under a pressure of* 100 *atmospheres to* 50° *F. During this process no sudden change of state can be observed, but carbonic acid at* 50° *F. and under a pressure of* 100 *atmospheres has all the properties of a liquid . . . by this process we have caused the substance to pass from an undoubtedly gaseous to an undoubtedly liquid state without at any time undergoing an abrupt change similar to ordinary liquefaction.*"

Again, on p. 206 of the "Text-Book of Physics," by Mr. Alfred Daniell, we find:—"If CO_2 gas be exposed to a temperature above 30°·92 C. and be subjected to any pressure above 73 atmospheres, it will still be a gas: *allow it to cool, the pressure being kept up, and it will be a liquid after it passes* 30°·92 *C., and yet the transition is unobservable.*"

I therefore propose to define the critical pressure of a substance as "that pressure above which it is impossible to make the substance undergo the *ordinary* process of condensation (or evaporation)"—or if greater amplification is needed as "that pressure above which an appropriate alteration of temperature causes the substance to pass from the gaseous to the liquid state or *vice-versa*, *by a process of continuous and imperceptible transition*, and not, as happens below that pressure, by *passage through the mixed state.*"

This definition I have given in my recently published book, "Physics: Experimental and Theoretical," but the *Times* reviewer, in a paragraph in that paper of July 29, characterises it as "mere nonsense."

I shall be greatly obliged if you will publish this letter, together with your opinion on the validity of my definition. Perhaps also some of your readers may favour me with an expression of their views. R. H. JUDE.

Newcastle-upon-Tyne, August 2.

Maternal Devotion of Spiders.

ON removing some virgin cork from the wall of a conservatory a short time ago, I was much struck with the way in which a small black female spider clung to her two egg-bags, despite the fact that the piece of cork to which she was clinging had been thrown roughly to the ground. When the cork was about to be replaced on the wall, it became necessary to turn the spider adrift, in order to prevent her being crushed. But although the cork was shaken, she declined to budge, and retained a tight hold upon her precious bags. Knowing how fully alive to danger the spider race is in general, I thought that this remarkable instance of devotion to maternal promptings on the part of a naturally sensitive creature ought not to be disregarded. I accordingly removed the mother very carefully, and placed her on some rockwork, where I noticed she seemed to be very uneasy, moving restlessly about as if searching for something. I then took the egg-bags and placed them beside her. As I expected, she seemingly failed to recognise them, or at least manifested a repugnance to them, and ran away for a little distance. Subsequently, however, she returned, and proceeded to examine the bags with scrupulous care by means of her palpi; and evidently satisfied with this scrutiny that they were really her own cherished property, she commenced to spin a web about them to secure them in their place.

Rennie has described experiments with the females of certain spiders which carry about their egg-bags attached to their bodies. When one of these spiders was molested, and its bag dragged with a stick, the mother seemed to lose all sense of personal danger in her anxiety for her unhatched offspring, and fought vigorously to retain her precious egg-bag. When forcibly deprived of the bag, she manifested great distress, and commenced a search for it, and, not finding it, she refused to leave the spot, seeming to be quite indifferent as to her fate. The curious part of the story is that when the egg-bag was finally restored to her, she refused to touch it, being apparently quite unable to recognise her property. In another case the spider regained possession of the bag as it was being withdrawn, and immediately refixed it in its former position.

My spider apparently recognised her egg-bags without much difficulty, and, furthermore, seemed to be alive to the danger to which they were exposed in their new situation by her act of spinning a protecting web without delay. When evening arrived, I observed that she had drawn the bags close up under a sheltering leaf, and was guarding them closely, having placed herself between them. FRANCIS J. ROWBOTHAM.

August 23.

THE CAMBRIDGE ANTHROPOLOGICAL EXPEDITION TO TORRES STRAITS AND SARAWAK.

THE main object of the expedition was to verify and supplement the anthropological observations that I made in Torres Straits in 1888–89, with the view of the publication of a monograph dealing with the anthropology of the islanders using that term in its widest sense. A few months before leaving I received such a pressing and enthusiastic invitation from Mr. Charles Hose for the expedition to visit the Baram district of Sarawak, that I felt constrained to extend the scope of our work by accepting his tempting offer. The party consisted of Dr. W. H. R. Rivers, Messrs. C. S. Myers, W. McDougall, S. H. Ray, A. Wilkin, C. G. Seligmann, and myself.

The Torres Straits islanders are Papuans, and as they inhabit the remains of the old land communication between Australia and New Guinea it was important that they should be thoroughly studied before it was too late. The islanders have been more or less under mission instruction since 1872, and some time before then the pearl-shelling industry had commenced. Owing to the varied influences of the white man, modification was bound to take place rapidly, and unfortunately in most islands more or less extensive depopulation has also occurred. There are two distinct tribes in the archipelago—the eastern tribe inhabits the Murray Islands, Erub (Darnley Island) and Uga, and the western tribe the remaining islands. The latter people have been most under the influence of white men, scarcely a pure-blooded native exists in Erub, but the Murray Islands, on account of their remoteness and the difficulties in reaching them owing to numerous coral reefs, have been less visited. As Mer, the chief island of this group is very fertile, and has a population of some 450 people, it appeared to be the best centre for our work.

We reached Mer on May 6, 1898, and took possession of the disused mission residence, which we speedily converted into anthropological, psychological and photographic laboratories. Here we measured 63 men, 5 women, 30 boys, and 22 girls. The average height of the men is 1·653 m. (5 ft. 5 in.); their cephalic index is 77·5. Although reference is made here only to the cephalic index and the height, I may state that we usually made

twenty-two measurements on the subjects in Torres Straits, New Guinea, and Borneo, besides a number of observations on the skin, hair, eyes, face, &c.

Psychological observations were made in the Murray Islands on about 150 individuals. Among the subjects investigated were visual acuity, delicacy of colour sense, colour blindness, binocular vision and visual perception of space; acuity and range of hearing, appreciation of musical intervals; tactile acuity and sensibility to pain, and discrimination of weight; acuity of smell; simple reaction time to auditory and visual stimuli and choice reaction time; estimation of intervals of time; the influence of various mental states on blood pressure; and the influence of fatigue and practice on the capacity for mental work. By means of colour matches, quantitative records were also taken of the colour of the skin of the islanders.

We were fortunate to find two or three old men who were able to tell us about the old customs and ceremonies. A good deal of time was spent in elucidating the long since abandoned sacred Malu ceremonies which were held in connection with the initiation of the youths; the previous account[1] can now be considerably augmented. Notes were made of various other ceremonies, and whenever possible the ancient sacred songs were recorded on the phonograph. A large collection was made of sacred stones, including stones about which there is a legend, sorcery stones, fishing and garden charms, rain and fire charms. Numerous legends were also collected, and many of the sites and stones connected with them were photographed by Mr. Wilkin.

The old oracle known as "*Tomog zogo*," which consisted of a group of large shells on stones, to represent each group of houses on the island, and a shell "house" for the *zogo*, was plotted, and the former method of divination was demonstrated to us. One or two members of the party learnt the constellations on the voyage out; this enabled us to map some of the native star groups. Attention was also paid to children's games, and a system of nomenclature was devised which enabled us to record with accuracy the complicated manipulation in the making of the ingenious string puzzles or "cat's-cradle." Examples of the past and present handicrafts of the people were collected. The construction of the language was carefully studied by Mr. Ray, and the previously published vocabulary increased. The native diseases and their cures were studied with the cognate charms and magic.

Messrs. Ray, Seligmann, Wilkin and myself paid a brief visit to the mainland of New Guinea, and visits were paid to Rabao (Yule Island) and to several villages of the Mekeo district. Twenty-eight men were measured: average height, 1·610 m. (5 ft. 3½ in.); cephalic index, 80. As the decorative art of the Mekeo district has not been described hitherto, numerous specimens of lime-gourds, tobacco-pipes, and painted tapa were collected.

A short stay was made at Port Moresby, where a number of photographs were taken to illustrate the manufacture of pottery, and a visit was paid to the Taburi tribe that lives behind Mount Warirata. Nine mountaineers from the centre of the Peninsula were measured: height, 1·607 m. (5 ft. 3¼ in.); cephalic index, 80·8, as well as fourteen Koiari from the hilly country: height, 1·600 m. (5 ft. 3 in.); cephalic index, 75·5; and six Koitapu of Port Moresby: height, 1·603 m. (5 ft. 3 in.); cephalic index, 77·1. A study of the Koitapu language was made, which proved that it, like the people themselves, does not belong to the Motu stock. These three groups differ in several respects from the Motu communities that inhabit most of the coast villages from Delena to Aroma; for example, they commonly wear hair on the face, and the hair is almost invariably frizzly.

A few days were spent at Bulaa (Hula), where we were struck by the relative prevalence of curly and even of wavy hair, and the general lighter colour of the skin: height, 1·663 m. (5 ft. 5½ in.); cephalic index, 82·5. I intend on a future occasion to discuss the physical characters of the Papuans at some length when I have had time to tabulate out our results, and to compare them with those of other workers. At present it appears to me that a short, slightly brachycephalic people live among the mountains, and a similar short mesaticephalic (with a distinct tendency towards dolichocephalism) folk live nearer the coast. It is the latter people who have been repressed by the taller brachycephals of the coast, whose foreign blood is shown by their lighter skin and a marked frequency of curly or even wavy hair. The mountaineers are in no sense a pygmy people, and are not directly related to the Aëtas; they frequently harass and conquer the dolichocephals.

Messrs. Ray, Wilkin and myself returned to Murray Island on July 20, Mr. Seligmann remaining behind to see more of the country. Dr. Rivers and Messrs. Myers and McDougall had made a large number of interesting psychological observations during our absence. The two latter left for Borneo on August 24.

On September 8 we left Murray Island and arrived at Saguane at the southern end of Kiwai Island in the delta of the Fly River on the 11th. A visit was paid to Iasa, which contains sixteen long houses, each of which is inhabited by members of one totemistic clan, and eleven natives were measured: height, 1·602 m. (5 ft. 3 in); cephalic index, 80·3. Mr. Seligmann rejoined us here.

Our next destination was Mabuiag, which we reached on September 17, and had five weeks of good work recording old customs, measuring natives, studying language and experimental psychology. In Mabuiag and Kiwai fewer psychological observations could be made, owing to the fact that most of the apparatus had to be taken on to Borneo, but observations on visual acuity, colour vision, &c., were made on over 100 individuals, many of whom, however, were not natives of these islands. Thirty-three men were measured: height, 1·648 m. (5 ft. 4¾ in.); the average cephalic index is 81·1. Although they belong to the same race, and are similar in many respects, there is a noticeable difference between the eastern and western tribe of Torres Straits. Most of their former ceremonies and many of their customs were dissimilar, the languages are quite distinct, and on the whole the western folk are more intelligent. The very slight difference in the stature may be due to the more abundant food of Murray Island, whereas that of the head form is of greater significance. The difference between an average index of 77 and 81 may not appear large, but there is a distinct difference in the form of the skulls in general from the two islands. I am inclined to believe that the Murray Islanders belong to that dolichocephalic stock which certainly occurs on the mainland of New Guinea in the region known under the general name of Daudai, and which appears to have been pushed back by a somewhat brachycephalic people. Murray Island was unaffected by this movement, but the western islands have not escaped it. I have no desire to push craniological facts too far, and I propose testing this hypothesis elsewhere by cultural evidence. Several writers have expressed an opinion that the natives of Prince of Wales Island and the neighbouring islands are Australians with a strong Papuan mixture. I regard them as Papuans, with a very slight (if any) Australian mixture.

The most interesting of our sociological investigations of the Western tribe were those on totemism, maturity customs for men and women, and the beginnings of hero-worship as exemplified in the legend and cult of Kwoiam, the national hero of Mabuiag. Here, as at Mer, Dr.

[1] *Internationales Archiv für Ethnographie* (vi., 1893, p. 140).

Rivers traced as far as possible the genealogy and relationships of every person on the island. This somewhat laborious work has proved a most valuable method of anthropological research, which, so far as I am aware, has not been attempted before for a whole community. The value of this method consists in the large number of accurate sociological data that are accumulated.

Short visits were paid to other of the western islands of the Straits in which ethnographical facts and specimens were collected.

At Mabuiag, and later at Thursday Island, we had an opportunity of studying some North Queensland natives, and the contrast, both mentally and physically, between them and the islanders was obvious. The average height of seventeen Queenslanders was 1·626 m. (5 ft. 4 in.), and their average cephalic index was 74·5.

We finally left Torres Straits on November 15, 1898.

Messrs. Ray, Seligmann and myself reached Kuching on December 12, where we had to remain until January 4; Mr. Ray occupied the time in learning Malay, and I laid the foundations of a study of the decorative art of Sarawak by utilising the collections in the most excellent museum which the Rajah has so wisely and liberally endowed. The foundation of the ethnographical collections was the very valuable Brooke Low collection, which the Rajah bought in England and reshipped to its native land. This has been added to from time to time, and, although there is a good deal to be done before all the handicrafts and arts of the natives of Sarawak are fully illustrated, the museum contains the best and most instructive collection of Sarawak ethnography extant. The fauna of Sarawak is also most fully represented, and the value of the collections is daily increased by the well-directed labours of the curator, Mr. R. Shelford.

During the north-east monsoon it is impossible for a steamer to cross the bar at Baram Mouth, and this necessitated our proceeding to Limbang, where we had to remain a few days whilst messengers were sent to Mr. Hose. We then had to journey some 200 miles in boats up the Limbang, Madalam and Trikan rivers, and after walking across the watershed at the foot of Mount Mulu we descended the Malinau, Tutau and Baram, arriving at Marudi (Claudetown) on January 28, where we rejoined Mr. McDougall, Mr. Myers having been obliged to return home a few days previously. On February 6 Mr. Hose took Messrs. Ray, MacDougall and myself an up-river trip, Mr. Seligmann was busy studying *upoh* (*upas*), *tuba* and other poisons; later he stayed some time among the up river Kayans. We went over 200 miles up the rivers Baram, Tinjar, Dapoi and Lobong, and saw many interesting scenes, and gained further experience of the jungle vegetation of a typical tropical land.

At Long Puah we witnessed the ceremony of moving the skulls into a new house from the hut in which they had been temporarily lodged, and then we participated in the ceremony of naming the first-born son of the chief. On the same occasion peace was made between two hostile tribes, and the covenant was ratified in the usual manner by "speaking" to some pigs, that were then killed and their livers inspected for augury. In one village we saw a Punan medicine man exorcise fever from a white man by means of incantations and obvious thaumaturgics. We gained fair insight into the mode of life and beliefs of several tribes of the interior; we made collections to illustrate their handicrafts and decorative art; numerous photographs were taken, which unfortunately have not proved a success owing partly to climatic conditions. Physical measurements were made of a large number of natives, and vocabularies collected. We also had an excellent object-lesson in the paternal administration of native affairs that is the keynote of the Sarawak system of government.

It was on this trip that I discovered a stone implement in a native house, close by the usual skulls and associated with other sacred objects. After great difficulty Mr. Hose succeeded in procuring it, and later he secured several other specimens of varied types. With the exception of a specimen in the museum at Oxford of a very different type from any we obtained, and one recently acquired by the Sarawak Museum, these are the only authentic stone implements known from Borneo. Mr. McDougall and I paid a hurried visit to Mount Dulit, but nothing of interest was collected.

Later on Mr. Hose took me to visit Tama Bulan, the great Kenyah Penghulu, who lives on the Pata River. Messrs. Myers and McDougall had previously visited him.

Towards the end of our stay in Baram we were present at a great peace-making, when quite 6000 natives assembled from all parts of the Baram district, and even from beyond its borders. We thus had an unique opportunity of seeing representatives of nearly every important tribe of the Raj. Amongst other incidents we witnessed a canoe race in which about one thousand men competed, and participated in an attempt to *tuba*-poison a large lake in which over two thousand men were engaged.

We have now in Cambridge specimens to fairly well illustrate the arts and crafts of the natives of Sarawak. Mr. Ray obtained material for grammars of the two dialects spoken respectively by the Land Dayaks and by the Sea Dayaks, as well as notes upon several other languages. Vocabularies of over 200 words were obtained in forty-six dialects spoken by various tribes of Sarawak. Mr. Myers made numerous psychological observations. Mr. Seligmann studied native medicine, &c. Mr. McDougall paid special attention to the question of the relations of men to animals and plants in Borneo, and helped me with the measurements and physical observations of the natives. In all we measured some 276 natives, the bulk of whom are mesaticephalic or slightly brachycephalic. The following are some of the approximate average indices (the numbers in brackets refer to the number of each tribe that were measured):—Maloh (7)—probably an immigrant people from Java—76; Barawan (17), 77·5; Kalabit (10), 78; Kenyah (103), 79—of these the Sibops (5) have the lowest index with 75·5, which gradually rises through the Malangs (20), 76·5, Tabalos (3), 77·5, Madangs (6), 78, Long Pokun (19) and Lirong (15), 79·5, Long Dallo (12), 80·5, Apoh (9), 82, to the Long Sinong Kenyahs (5), with an index of 83·5—this does not appear to be a very homogeneous group; Kayan (22), 80; Long Kiput (9), 80·5; Punan (22), 81; Sea Dayaks (53), 83; Malanaus (7), 85·5; Brunei-Malay (1), 85·5. We have not yet had time to study the skulls we brought away. I had an opportunity, however, of measuring five Murut skulls at Limbang, which had an average index of 75· (extremes 73-77·5). It is thus evident that there is a dolichocephalic element in Borneo which may be identical with the Indonesians as defined by de Quatrefages and Hamy in "Crania Ethnica." There is also a low brachycephalic element found among the up-river Kenyahs (Long Sinong, Apoh, and Long Dallo), Punans, and to a less extent among the Kayans. The Sea Dayaks are not an indigenous population; they probably constituted the advance wave of a later Malay migration. The Malanaus are Mohammedans greatly influenced by Malays, and who very frequently artificially deform the heads of their babies, so their relatively high index of 85·5 may be neglected. Although the Punan cephalic index (81) is close to that of the Sea Dayaks (83), the slender pale-coloured forest-dweller is physically very different from the short, sturdy, dark-skinned, low-country agriculturist. We were fortunate in coming across several groups of Punans, a nomadic jungle folk who are certainly one of the most primitive people in Borneo, and who may, perhaps, be the true autocthones of the country, for there is no

authoritative evidence for the existence of Negritos in Borneo.

The fascinating promises of Mr. Hose when he sent me his invitation to visit him were amply fulfilled so far as time permitted, and we have to thank him for a most enjoyable and instructive visit. Mr. Charles Hose is well known as a highly successful and enthusiastic naturalist. He has made collections in all departments of the land fauna of Sarawak, and he has monographed the mammals and the birds. His geographical explorations are also well recognised; but it is not generally known that he has a most minute and extensive knowledge of all that pertains to the numerous and varied natives that have been entrusted to his sympathetic care. I have seen piles of immensely valuable ethnographical manuscript which we sincerely hope will be suitably and speedily published. Not only has Mr. Hose from time to time presented his old University with numerous zoological specimens, but he has entrusted to me an extensive and very valuable collection of ethnographic specimens which he has given to the University of Cambridge. In addition he has presented the unique collection of stone implements and a large collection of human crania, each skull being labelled with its tribe and provenance.

I shall endeavour on another occasion to do justice to Mr. Hose's success as an administrator. What we were able to accomplish was largely due to those personal qualities of a ruler which awaken a feeling of affection and loyalty in the natives.

The Cambridge University Press will publish the scientific results of the Expedition in due course as a series of memoirs which will be obtainable separately. The volume on experimental psychology will be written by Dr. Rivers and Messrs. Myers and McDougall, with some supplementary observations on the natives of the mainland of New Guinea by Mr. Seligmann. Mr. Ray has ample matter for a volume on linguistics.

The linguistic results of the Expedition were on the whole very satisfactory. Materials were obtained for complete grammars of the two Torres Straits languages, and the vocabularies were revised. In New Guinea the Melanesian languages around Hood Bay were studied, as well as those of Rabao (Yule Island) and the adjacent mainland. In New Guinea also material was obtained to elucidate the somewhat complex structure of the Papuan languages of the Koitapu in the Port Moresby district, of the Cloudy Bay peoples, and of the Kiwai and Mowatta tribes in the Fly Delta. No grammar of any of these languages has hitherto been written. The materials obtained in Borneo for grammars of the two dialects spoken by the Land Dayaks and Sea Dayaks, and vocabularies obtained in forty-six dialects spoken by various tribes of Sarawak have already been referred to.

The physical anthropology of Torres Straits and New Guinea will mainly be worked out by myself, but Mr. Seligmann has some additional measurements from the mainland of New Guinea. Dr. Rivers will publish and expound his statistical inquiries. Mr. Myers is making a comparative study of native music. Mr. Seligmann has studied native medicines and charms, and has made various ethnological observations of some interest. Mr. Wilkin has made notes on native houses in New Guinea. The religious ceremonies, legends, and general ethnology will be treated by various members of the Expedition. Mr. Wilkin took a large number of excellent photographs in Torres Straits and New Guinea, which will be drawn upon for illustrative purposes. As there is no room for them in the present Museum of Archæology and Ethnology, the extensive collections are deposited temporarily in a couple of small houses in Cambridge, where, unfortunately, they run risk of deterioration.

ALFRED C. HADDON.

WHY PEOPLE GO TO SPAS.

ANY observer who has the curiosity to pass in review the modern methods of medical treatment cannot fail to be struck by the increasing amount of attention which is being paid at the present time, both by the laity and the profession, to the spa treatment of disease. The fact that many thousands of patients flock annually to the different health resorts to seek relief from their ills, and the idea which prevails among a large section of the educated public, chiefly the well-to-do classes, that their existence is not complete without a yearly visit to one or other of the many spas, either at home or abroad, and that for their bodily well-being an annual "cure" is necessary, are phenomena which call for comment and demand explanation. The practice is by no means of recent growth, for it finds its origin in the almost universal belief, prevalent in ancient times, in the efficacy of natural mineral waters and baths in the cure of disease. Many instances of this might be quoted. The waters of Spa in Belgium were celebrated in the time of Livy; the Romans built Bath in England, and fully recognised the value of its springs; and they in turn derived their fondness for bathing from the Greeks. There is not wanting evidence to show that more ancient civilisations appreciated in a rude way the benefits to be obtained in this direction from the resources of nature. Throughout the middle ages the same belief was held, and many were the pilgrimages to the various springs then known. In the present day the same idea, shorn of much of the superstition that formerly clung to it, still prevails, and each watering place claims annually its numerous devotees. Not only among the laity is the assurance of the therapeutic value of natural mineral waters and baths firmly rooted, though doubtless there still remains a substratum of lingering superstition as a part foundation of that assurance, but also by the medical fraternity their utility is accepted, as is witnessed by the freedom with which their patients are sent to take the waters of this or that spring. In the minds of the latter, however, superstition has been replaced by knowledge, and they are well assured that such treatment has a definite and real value.

It becomes, then, a matter of interest to seek answers to the following questions: Whether, in the light of modern knowledge and research there is a solid foundation in fact for the faith that is placed by patients and their doctors in the utility of bathing and water-drinking; whether such measures possess any advantages over treatment by ordinary medicinal means; whether the lines of treatment followed at spas cannot be carried out equally well at the patient's home, and the necessity for a perhaps inconvenient visit to a watering place thereby be obviated; and, lastly, whether equal facilities for such treatment, and results equally good, are not obtainable in this country as at similar places on the continent?

Up to comparatively recent times the use of waters and baths in the cure of disease was purely empirical. Through long experience and repeated trial it came gradually to be ascertained that certain waters were beneficial in certain cases, and certain kinds of baths produced certain effects; wherefrom was elaborated a system of spa treatment on more or less rule of thumb principles. The exact nature of the action of these agents, the physiological effects they produced and the pathological conditions they influenced were ill-understood; the rationale, in short, of the treatment was wanting. Of late years, however, a large amount of sound scientific work has been done in this department of medicine. The action of mineral waters and baths has been made the subject of definite experiment and the results obtained applied to the perfection and extension of the methods; and thereby this branch of therapeutics, which

formerly afforded tempting opportunities for scornful criticism on the part of the more advanced members of the profession, has now been placed on a firm scientific basis, and the ancient faith in it fully justified.

In this as in many kindred subjects the lead was taken by Germany, and as the result of much painstaking research a large amount of literature has appeared relating to the various spas in that country. Latterly the home watering places, such as Bath, Buxton, Droitwich, Harrogate, Leamington, Llandrindrod, Strathpeffer and others, have been brought more prominently before the notice of medical men, and through them to the public, by reason of similar research work conducted on scientific lines into the nature of the action of their respective waters and baths, by which their claims to equality with, if not superiority over, many of the continental resorts have been abundantly demonstrated. To illustrate this let us take Harrogate as an example, as possessing the greatest number and most varied assortment of mineral springs, and the most complete bathing establishment in this country, if not in Europe, and consider it with regard to its waters and baths. The former, some eighty in number, may be classified into certain groups of saline-sulphur waters, alkaline-sulphur waters, pure sulphur waters, saline-

FIG. 1.—Entrance-hall and pump-room at the Royal Baths, Harrogate.

chalybeate waters, and pure chalybeates, each group embracing several members presenting fine gradations in quality and strength. The most important of these are set apart for drinking purposes; the others being collected, stored, and used for bathing. Long experience and trial of the waters has indicated the class of diseases in which they may be expected to prove beneficial, either individually or in combination, and these fall somewhat definitely into the following main groups, which, however, by no means include all cases which may derive benefit: disorders of the liver, functional or organic; cases of gout in its many manifestations; cases of rheumatism and so-called rheumatic gout; and cases of skin disease. The results obtained have been good, though based upon empirical knowledge, and a considerable reputation has been built up. In recent years, however, this has been strengthened by experimental work which has been carried out to determine the *modus operandi* of many of the waters, and the results of these researches have not merely corroborated in the main empirical practice, and furnished reasons for it, but have indicated new directions in which these agents may be advantageously employed. For example, the Old Sulphur Spring, the most valuable possession of Harrogate, has long been used in the past as a stimulant to the liver in sluggish or congested conditions of that organ. Recent research has shown by experiment on man and on animals that administration of this water definitely increases the flow of bile, as to rapidity, quantity, and the amount of solid constituents. And a further indication of increased activity of the liver is proved by an increase in

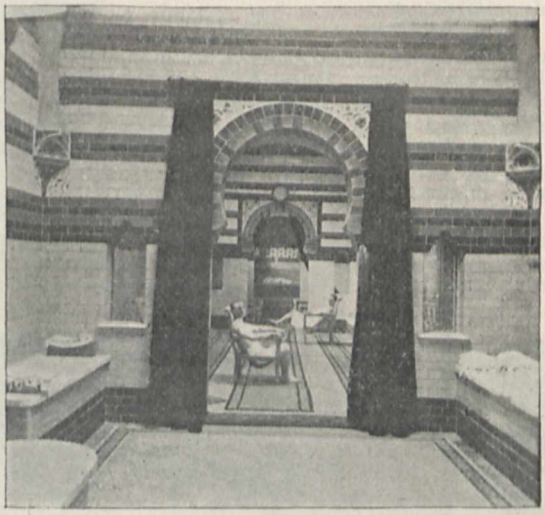


FIG. 2.—Interior of the Turkish Bath.

the amount of urea eliminated from the body. It has been used largely as a valuable remedy in gout, a part explanation of which is furnished by the diminished production of uric acid, which experiment shows to be one of the effects of this water. It has a well-marked effect on the blood in diluting it and diminishing slightly the amount of hæmoglobin, which explains its frequent use in plethoric conditions. The milder sulphur waters have

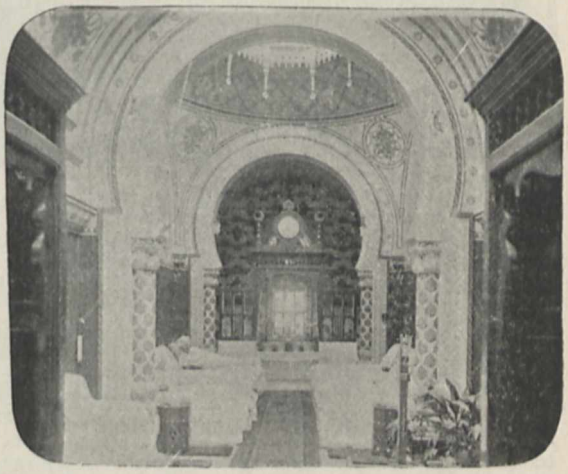
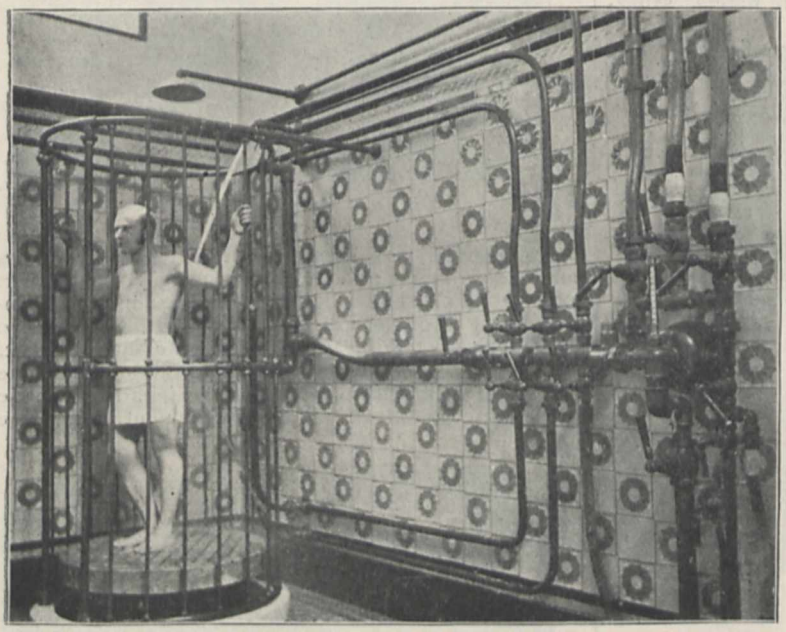


FIG. 3.—Cooling room of Turkish Bath.

been shown to have similar effects to a less extent. Further, the group of iron waters have been examined, and their effect on the blood in the building up of hæmoglobin repeatedly proved, and other unsuspected results on the general vital processes of the body been discovered, the Chloride of Iron water, for example, markedly increasing the elimination of urea, and diminishing that of uric acid; the "Kissingen" water

increasing the flow of bile without increasing the solid constituents; and so forth. Research of this description has been and is being carried on in the health resorts of this country, and though finality has by no means been reached, yet such endeavours to add to our knowledge should go far to enhance the reputation of each, to increase the confidence of patients who seek health there, and to remove any lingering prejudices that may still remain in the minds of scientific men as to the true worth of such treatment.

With regard to the baths, inquiry as to their mode of action has proved quite as satisfactory as in the case of the mineral waters. Through the forward policy adopted at Harrogate in providing a new and magnificent suite of baths including almost every variety, and replete with every modern convenience, it is possible there to undertake and carry out any line of balneo-therapeutic treatment that may be desired. The methods in use at the continental spas have been adopted and in some cases improved upon, any new development being at once installed and its utility or otherwise determined. The baths available, using the word bath in its widest sense,



Greaves.] [*Harrogate.*

FIG. 4.—The combined needle and douche bath.

may be classified into (*a*) *Thermal* baths, depending for their action mainly on the element of temperature, and including plain water baths, hot and cold, Turkish, Russian, superheated air baths, &c. (*b*) *Thermo-chemical* baths, in which there is added to the effects of temperature the effect of the chemical constituents of the water. They include the saline sulphur baths, alkaline-sulphur baths, saline baths, Nauheim baths, &c. (*c*) *Thermo-mechanical* baths, in which there is added to the effect of temperature the mechanical action of the water in the form of sprays, douches, effervescence, &c., with or without the mechanical effect of massage. These include the needle bath, combined needle and douche, running sitz bath, &c., and those with massage, the Aix douche and the Vichy douche. (*d*) *Thermo-electrical* baths, in which a current of electricity, either constant or interrupted, is passing through the water.

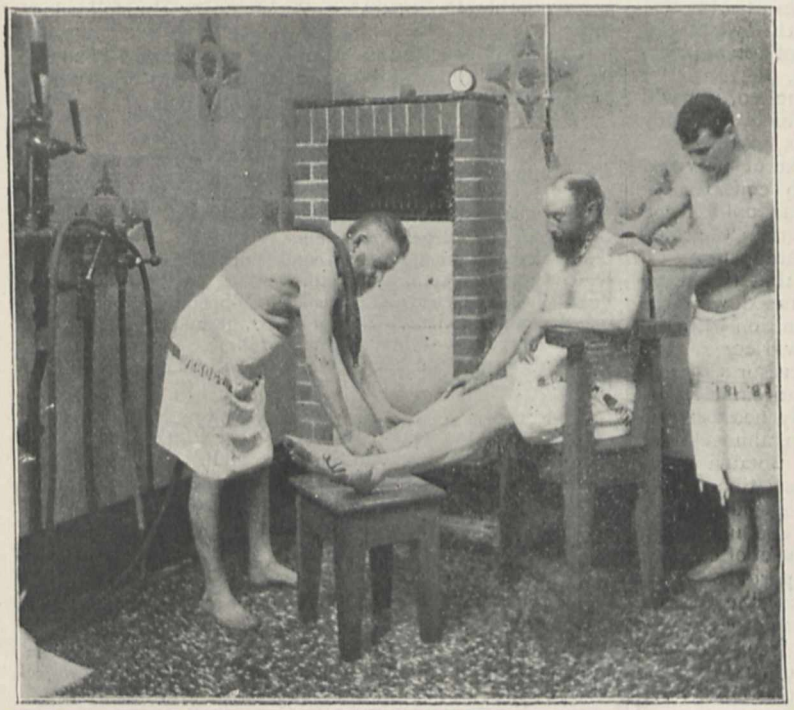
Each and all of these baths have their special effects, and abundant observations have been made to determine them experimentally as a guide to their intelligent use. The factors at work in the human organism that are disturbed in greater or less degree by even simple baths are so many, and their interaction so complex, that it becomes a matter of great difficulty, in the first place to measure them, and, in the second place, to estimate their relative importance; while in the case of the more complicated baths, where different elements, thermal, chemical or mechanical, are brought into play to disturb these factors, some in one direction and some in another, often apparently in direct opposition to each other, the difficulty becomes even greater. Thus, while we are able to ascertain approximately the net physiological result in any given case, it is impossible in the present state of our knowledge to do more than hazard conjectures as to the exact mode by which that result was produced—to what extent one factor was concerned and to what extent another. Still, in spite of the difficulty, collation of the results of various workers at home and abroad enables us to understand in some degree the rationale of bath treatment, and to place it on a sound physiological basis.

The influence of bathing in its various forms on the animal economy is profound, and no one who has not specially observed the effects produced can form an adequate idea of how potent that influence is. Broadly speaking, it may be said that the effects produced are the result of changes that take place in the circulatory system, which is the system mainly acted upon by the factors—thermal, chemical or mechanical—that may be at work.

The heart, driving the blood with its contained nutriment, derived from the alimentary canal, through a closed system of tubing, consisting of arteries, capillaries and veins, enables that fluid to penetrate to all parts of the body, there to deliver up its charge of food to the tissues by interchange of fluid through the thin capillary wall; receiving in exchange the waste products from the tissues, and bearing them away to be eliminated from the system. Variations in the amount of blood, and the force with which it is driven into the circulation at each heart beat, and variations in the calibre of the closed system of tubing will, with other factors, determine the tension of the circulation, or fluid pressure under which the blood is working—the blood pressure, as it is called. These variations are controlled by a nerve apparatus, the vaso-motor mechanism, whereby dilatation of vessels in one region of the body is compensated for by contraction in another, and the average level of blood pressure maintained, or changes produced therein. On the integrity of this nerve mechanism, and the perfect performance of its functions, the maintenance of health largely depends, for by it the ebb and flow of vessel constriction and dilatation is controlled, and the circulation enabled to adjust itself to the rapid succession of changes that take place in the environment of the organism—changes due to gravity, posture, exercise, digestion and the like. Further, on these changes in blood pressure depends to a large extent the ebb and flow of fluid through the capillary wall, whereby nourishment is conveyed to and waste products removed from the tissues; and, consequently, where this function is impaired the nutrition of the whole body suffers. By the recent introduction of new instruments it is possible to measure directly the blood pressure in the human subject, and to observe its

variations from hour to hour or day to day; and also to measure the varying calibre of the arteries in the extremities. We are thus able to form a fairly accurate estimate of the conditions of the circulation, and from these observations to infer the completeness or otherwise of the nutritional processes on which depend the well-being of the individual. In different morbid conditions the blood pressure may deviate considerably from the normal, the vaso-motor mechanism be impaired, and the free interchange of blood plasma and tissue fluid be defective, to the detriment of the organism. Experiment has shown that the blood pressure is markedly affected by baths, some procedures having the effect of raising it and some the reverse. The effect, though at first temporary, is cumulative, so that a permanent modification of pressure may be obtained, from which it follows that an intelligent use of bathing as a therapeutic agent can so act on the circulatory system as to regulate the blood pressure, restore the normal mobility of the vessels, promote the interchange of tissue fluid, and profoundly modify nutrition. By means of these new methods we can watch closely the changes occurring under treatment, and can adjust the latter to the requirements of any particular case with a delicate nicety.

A few instances may be given of the effect of various baths on the blood pressure. Heat in all forms, whether dry as in the Turkish bath and superheated air baths, or moist as in the Russian bath, or the simple immersion bath, lowers the pressure. Cold, on the other hand, has the effect of raising it. The chemical constituents of the water in the case of the saline and sulphur baths also exert an influence, augmenting the fall in pressure resulting from warm baths. The percussion of water impinging sharply on the skin, as in the needle bath, tends to raise the blood pressure. Massage to the limbs and body causes a fall in pressure, provided the abdomen be not massaged too vigorously; deep pressure and manipulation of this part is followed by a marked rise in pressure owing to the dispersal of blood from the capacious veins of the viscera into the general circulation. In the Aix and Vichy douches massage is combined with warm douching.

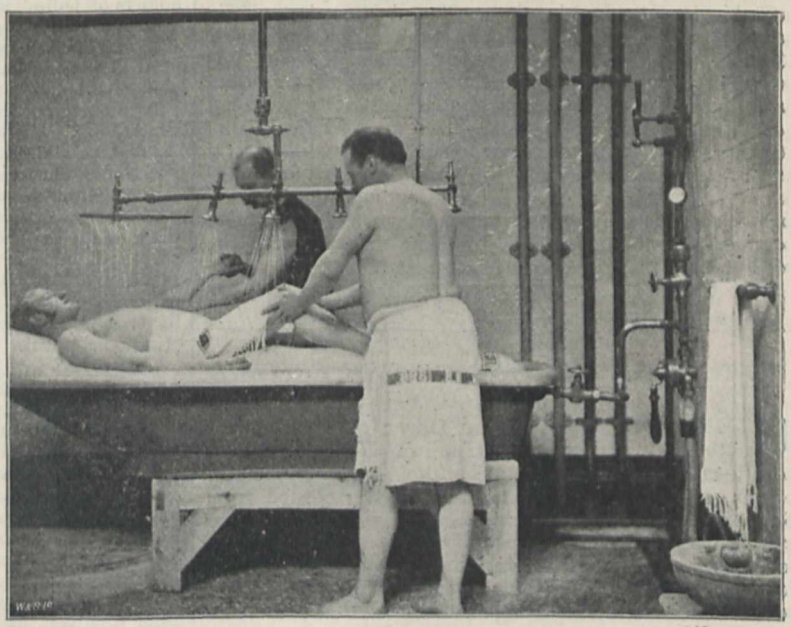


Greaves.] [*Harrogate.*

FIG. 5.—The Aix douche.

In the former bath, massage is administered under a simple douche conveyed by a flexible pipe passing over the shoulder of the attendant and playing between his hands, the patient being in the sitting posture. The result on the blood pressure is to produce a fall, the massage and heat acting in the same direction. In the Vichy douche, however, the patient lies in the recumbent position, and is massaged under a needle spray falling from a bracket suspended over the table. Owing to the position adopted, massage of the abdomen is more freely performed, and this, combined with the tonic effect of the percussion of the needle spray, produces as a net result a rise in pressure.

The above considerations as to the mode by which tissue change is stimulated and nutrition modified by agents brought to bear on the circulatory system, serve to explain certain more remote effects experienced as the result of baths. To enter into these in detail is impossible within the limits of an article of this description: suffice it to mention one bath only. The Aix douche



Greaves.] [*Harrogate.*

FIG. 6.—The Vichy douche.

has the effect of increasing the amount of urea eliminated, and the excretion of uric acid is markedly augmented, which fact, viewed in conjunction with the diminished production of uric acid resulting from administration of the old sulphur water, explains the happy results obtained in the treatment of gout by the use of this water and bath, the one diminishing the production of the *materies morbi*, the other facilitating its elimination.

In answer to the question first propounded, it would appear then that modern research has not only abundantly justified pre-existing views as to the value of spa treatment, and has to a large extent provided sound reasons for them, but has also considerably extended its sphere of usefulness, and has uplifted the methods from the dead-level of empiricism to the more exalted domain of rational and scientific therapeutics.

The foregoing remarks suffice to show that the home watering places have of late years advanced with the times, and are able to claim equal recognition with the best known continental resorts. The variety of the waters to be found at the different health resorts of this country is such as to cover almost all requirements, and there are few cases indeed which it is really necessary to send abroad. In the matter of baths, also, almost every known balneo-therapeutic procedure is obtainable in Great Britain, and the methods of administration are as carefully supervised and as efficiently carried out as elsewhere. The one element in which we are unable to compete with our rivals abroad is in the matter of climate, for we cannot ensure the same protracted periods of sunshine that many of them enjoy. Nevertheless, the weather experienced during the season at the home resorts is not necessarily incompatible with a successful "cure," and is indeed preferred by many, by reason of its bracing qualities, to the hot and relaxing climates of some of the continental spas.

In estimating the value of spa treatment other factors besides the administration of waters and baths must be taken into consideration; such, for instance, as change of air, rest, freedom from business anxieties or household cares, regular habits of living—early rising, simple moderate diet, and so forth—all of which play their part in achieving the end in view. Therein lies the superiority of spa treatment over ordinary medicinal means in suitable cases, mainly of chronic ailments, and the impossibility of fulfilling these necessary conditions renders futile the attempt to follow out similar lines at the patient's own home. Indeed, by many the major influence is attributed to these factors rather than to baths and waters, and in some cases this may be true. But, while recognising fully their importance, the foregoing rough indication of some of the modes in which waters and baths have been proved to act suffices to show that to these the predominant influence must be assigned.

WILFRID EDGECOMBE.

THE DOVER MEETING OF THE BRITISH ASSOCIATION.

INTENDING visitors to the Dover meeting should note that this year the chief railway companies afford additional facilities to members of the Association. They offer a return ticket at a fare and a quarter, issued from September 12 to 20, available for return till September 27. Those who wish to avail themselves of this privilege must obtain from the Secretary a signed cirtificate, which must be given up to the booking clerk when the ticket is purchased. The following railway companies have entered into this arrangement:—The Caledonian, Great Eastern, Great Central, Great Northern, Great Western, London, Brighton and South Coast, London and North Western, London and South Western, Midland, North British, South Eastern and Chatham and Dover. The usual arrangement for places within fifty miles of the place of meeting still holds good, in virtue of which a return ticket at a single fare may be obtained at Dover on production of membership tickets. These tickets are available for return on the same or the following day.

The local programme is now in the press. It may, however, be useful to recapitulate the items of general interest which will appear in the programme.

SECTIONAL MEETING ROOMS.

A—Mathematical and Physical Science—School of Art, second floor.
B—Chemistry—School of Art, first floor.
C—Geology—College Gymnasium.
D—Zoology—School of Art, second floor.
E—Geography—Apollonian Hall.
F—Economic Science and Statistics—Co-operative Rooms.
G—Mechanical Science—School of Art, ground floor.
H—Anthropology—Rifle Volunteer Hall.
I—Physiology—Chemical Lecture Room, School of Art.
K—Botany—Union Hall.

PRESIDENT'S ADDRESS AND EVENING LECTURES.

These will be delivered in the Town Hall.

President's Address.—On Wednesday, September 13, the first general meeting will be held at 8 p.m., when Sir Michael Foster, K.C.B., Sec.R.S., will assume the presidency and deliver an address.

First Evening Lecture.—On Friday, September 15, at 8.30 p.m., by Prof. Charles Richet, of Paris. Subject: "La Vibration Nerveuse."

Second Evening Lecture.—On Monday, September 18, at 8.30 p.m., by Prof. Fleming, F.R.S. Subject: "The Centenary of the Electric Current."

ENTERTAINMENTS AND GARDEN PARTIES.

Thursday, September 14.—The Chairman of the College Council, Dr. E. F. Astley, the Headmaster and Masters of Dover College, invite members, associates, and holders of ladies' tickets to a garden party in the College Close, from 3.30 to 6 p.m.

The Mayor, Councillor Sir W. H. Crundall, J.P., and the Mayoress, Lady Crundall, invite members, associates, and holders of ladies' tickets to a conversazione at the Town Hall, from 8.30 to 11.30 p.m.

Friday, September 15.—Lord George Hamilton, Captain of Deal Castle, invites two hundred members, associates, and holders of ladies' tickets to visit the Castle, from 3.30 to 6 p.m.

A smoking concert in honour of the President, Sir Michael Foster, F.R.S., will be given by the Local Committee in the Apollonian Hall, Snargate Street, commencing at 10 p.m. A selection of music will be performed by the band of the Royal Artillery from Woolwich, by special permission.

Saturday, September 16.—A grand military tattoo will take place on the sea front, opposite Waterloo Crescent, at 9.30. A space will be reserved for members, &c. Admittance on presentation of Association ticket.

Monday, September 18.—The Mayor and Lady Crundall invite members, associates, and holders of ladies' tickets to an "at home" at the Connaught Park, from 4 to 6.30 p.m.

Tuesday, September 19.—On Tuesday afternoon, September 19, a motor-car exhibition will be opened at the Dover Athletic Grounds by the Mayor.

Lord Northbourne invites 200 members, associates and holders of ladies' tickets to visit Betteshanger Park, from 4 to 6 p.m. Light refreshments will be offered.

Lord George Hamilton, Captain of Deal Castle, invites 200 members, associates and holders of ladies' tickets to visit the Castle, from 3.30 to 6 p.m.

The Local Committee invite members, associates and holders of ladies' tickets to a garden fête in the Granville Gardens, from 9.30 to 11.30 p.m. The band of the Royal Engineers, from Chatham, will, by special permission, perform a selection of music during the evening.

THE MUSEUM.

The Dover Museum, in the Market Square, is well worth visit, as it contains a large number of objects interesting both to

antiquarians and lovers of natural history. The collections owe much to the care and interest of Dr. E. F. Astley, the hon. curator. The assistant curator will be glad to afford visitors every assistance. The anthropological collection, though small, is interesting, and contains a valuable feathered cloak from the Sandwich Islands, a Maori's head, and many war trophies from New Zealand. The "Plomley" collection of British birds, presented by the late Dr. Plomley, is specially rich in local specimens. The collections have been enriched by many gifts from the Hon. Walter Rothschild, who takes considerable interest in the Dover Museum. There is a good collection of British birds' eggs, including those of the peregrine falcon, once common on the Dover cliffs, but now becoming exceedingly rare. Prehistoric and local antiquities are well represented. The collections of shells, insects and fossils are also noticeable.

Visit of the French Association to Dover.

On Saturday, September 16, the members of the Association Française pour l'Avancement des Sciences will visit Dover. On their arrival, about 9.30 a.m., they will partake of a light repast at the Lord Warden Hotel. At eleven o'clock there will be a reception at the Town Hall, when addresses of welcome will be delivered. Afterwards various Sectional Meetings will be visited. At 1.30 there will be luncheon in the marquee in the College Grounds. Tickets for the luncheon (price 15s., including wine) will be on sale at the Reception Room. In the afternoon the members of the French Association will visit the Castle and other objects of interest in Dover.

Visit of the British Association to Boulogne.

On Thursday, September 21, the members of the British Association will visit Boulogne. A special boat will leave Dover about 8.30 a.m., arriving at Boulogne about ten o'clock. After a reception, the various sections will be visited, and subjects mutually interesting to the two Associations will be discussed. At 12.30 the Municipality of Boulogne will entertain the Associations to lunch. The luncheon will be followed by a Reunion with addresses. In the afternoon a plaque to the English poet Campbell will be unveiled, and a statue to the French man of science, Duchenne, will be inaugurated. The afternoon will be spent in visiting the town of Boulogne. In the evening those members of the British Association who do not intend to take part in the five days' excursion will leave for Dover. Sleeping accommodation will be provided in Boulogne for those who intend to visit the towns of Northern France and Belgium on the excursion commencing the following morning (Friday).

Handbook.

The Local Committee have prepared a special handbook to Dover and the neighbourhood, containing articles on the history and antiquities, the geology, the entomology, the vertebrate fauna, the botany, the climate, the river and tides, the docks and other engineering works, the trade, commerce, and industries. This book is illustrated with maps and plans, some of which contain new work. The information given in the maps and plans and the articles, written by specialists on the subjects they deal with, will, it is hoped, render the work not only useful on the occasion of the British Association's visit, but also of some permanent value.

Excursions.

Wednesday, September 20.—Excursion to Canterbury. The Mayor of Canterbury and the Corporation invite the members, associates and holders of ladies' tickets to Canterbury in the afternoon, to meet the President and one hundred members of the French Association. Special facilities will be given for visiting the various places of industry in the city. The Dean and Chapter will receive the guests at the Cathedral after the Mayor's reception at the Royal Museum.

Thursday, September 21.—(1) Visit of members, associates, and holders of ladies' tickets to the Association Française pour l'Avancement des Sciences at Boulogne. A special steamer will leave Dover at 8.30 a.m. (2) Excursion to Chatham Dockyard and Rochester Cathedral. Limited to 200. (3) Excursion to Wye Agricultural College, to inspect experimental farm. Luncheon will be provided by the Principal, Mr. A. D. Hall. Guests limited to eighty. (4) A circular tour through the Weald of Kent, including stoppage at about five towns between Dover and Tunbridge Wells, and extending over two days. Limited to fifty persons.

Friday, September 22.—There will be a five days' excursion in France and Belgium, to Abbeville, Amiens, Arras, Brussels, Antwerp, Ghent, and Ostend, at the conclusion of meeting. The excursion will start from Boulogne on Friday morning, September 22, when sleeping accommodation will be provided for those not returning to Dover after the visit to the French Association.

Church Services.

There will be special services at most of the churches on Sunday, September 17. At St. Mary's there will be a special service for members of the Association at 11 a.m., when the Rev. Archdeacon Wilson, D.D. (late Headmaster of Clifton) will preach.

The railway companies will afford facilities for those wishing to visit Canterbury on Sunday. The Very Rev. Dean Farrar (Vice-President of the Association) has arranged the following special services:—

10.30 a.m.—The sermon will be preached by the Lord Archbishop of Armagh.

3 o'clock p.m.—The sermon will be preached by the Rev. Canon Mason, D.D. The sermon will be followed by an organ recital.

6.30 p.m.—The sermon will be preached by the Very Rev. the Dean.

W. H. PENDLEBURY.

THE NEW PHILHARMONIC MUSICAL PITCH.

THE question of musical pitch has, through the action of some of the leading pianoforte makers, been again introduced into public discussion. That it should end in the general adoption of the French diapason normal hardly admits of a doubt, especially as it is in the United Kingdom only there remain any advocates for the high pitch formerly general. France introduced by law the diapason normal in 1859, and has been gradually followed by Belgium and Italy, Germany and Austria, Russia and the United States of America, leaving this country in musical isolation from which a great effort has yet to be made to bring it into uniformity with other musical countries, so that the note A will be approximately the same here as anywhere else, and not give the impression of a transposition. The difference of vibration number is not so very much; if it were a semitone, it might be easier rectified—at least in concert organs—it may be stated at 3/5, or at most 2/3 of an equal semitone. It is measurement and the important consideration of temperature that justify the admission of a subject, at the first aspect merely artistic, into the columns of NATURE. Temperature has as yet met with insufficient consideration. It is hardly alluded to in the "Sensations of Tone" by Helmholtz; it meets with a bare mention only, although somewhat extended in the footnotes of the English translator, the late Dr. A. J. Ellis, who refers (p. 90, second edition) to the experimental work in that direction of Mr. Blaikley.

It is well known that the Paris diapason normal is stated as A=870 vibrations a second at 15° C. As we reckon by complete vibrations, we take this number at one-half (435), with the temperature by the Fahrenheit thermometer (59°). Although this is a very good temperature for open-air music, as military bands, &c., it is not high enough for operas and concerts taking place in confined spaces with audiences and artificial lighting. The opera and concert orchestras have, therefore, everywhere to find their own pitch evolved from the Paris standard to suit an average increase of temperature. If the French Commission had decided upon 20° C. (68° F.), the necessity for an empiric proceeding would have been avoided. They might very well have adopted Scheibler's suggestion, made in 1834 at Stuttgart, of A=440. It is known that he worked at a temperature of about 70° F. To him we owe the only facil

tonometer, for which his pitch was really A=439·5. It is as well to go back to the protocols of the Congress at Vienna in 1885, which led to the adoption of the French pitch in Austro-Hungary. After a unanimous acceptance of the diapason normal at 15° C. it was proposed that, in order to keep the wind instruments in performance to the initial standard vibration number A=435, the brass and wood wind instruments, and also the organ, should be made for 24° C. (75·2 F.)!—thus introducing a second standard to be used concurrently with the first, the necessity attributable to the vibration number being increased automatically by the heating and rarefaction of the air increasing its velocity, and with the orchestral wind instruments by the breath and handling of the players. Mr. Blaikley has shown the velocity of air in pipes is always less than in free air, possibly through the friction of the walls, but in the organ flue pipes it comes so near to free air that the organ may be almost regarded as a thermometer. So high a temperature as 24° C. was not left unchallenged; a wiser determination was urged of 20°, which in practice would have proved right. However the great differences likely to arise in average temperatures due to climatic conditions, and to warming and lighting apparatus, as, for instance, gas or electricity, prevented a decision from being arrived at; so that Vienna is now, as London was pending the decision of the Philharmonic Society, using a convenient empiric pitch of about A=440 for concert performances. Ingenious as the Viennese plan in 1885 would have been, it is wiser to have one standard with one note, A, for its expression, and one mean temperature. For brass instrument makers a B flat fork may be used, and to suit the old custom of organ-builders and pianoforte-makers, a C fork; but in preparing them equal temperament should be rigidly observed.

In 1879, at the instance of Mdme. Adelina Patti, the Covent Garden Opera adopted French pitch; a recent trial in performance satisfied me that it was at A = 440, the temperature being about 70° F., and that there had been no departure from the intention of using the French standard. Little notice has at any time been taken of this important change at the Opera; but when the Queen's Hall was opened in 1893, Mr. Newman, the manager, and Mr. H. J. Wood, the conductor, lost no time in introducing the diapason normal for all performances for which they were responsible; the proprietors going to the expense of having the organ, which had just been built at the high pitch, lowered. Mr. Henschel, in his symphony concerts at St. James's Hall, and in founding the Scottish orchestra, speedily followed. But the decisive point for this country was reached when, in July 1896, the Philharmonic Society, the most eminent musical institution in this country, elected to adopt the French diapason normal, and in the following November decided to have a standard tuning-fork for their concerts. Having consulted me, the directors accepted my suggestion for that pitch that it should be A=439 at 68° F. Forks made for the Society by Valantine and Carr, of Sheffield, were verified by me with the aid of the Scheibler tonometer in the Science Department, South Kensington, and besides the one retained by the Society, accurate copies were presented by the directors to the Science and Art Department, the Society of Arts, the Royal Academy of Music, the Royal College of Music, the Guildhall School, Trinity College, London, and myself; the last being accessible on all lawful days at Messrs. John Broadwood and Sons, 33 Great Pulteney Street, W. The B flat is stated in the same minute of the Society as=465, the C=522; this last happens to be a just minor third above A=435, an accidental, although useful, coincidence.

The vibration number 439 is really the French standard raised to an average performing temperature, theoretically by my coefficient of a thousandth part of a complete vibration a second for one degree Fahrenheit, so that for 435 the rise for the next degree is ·435. In a variety of ways I have sought an average concert temperature which I have finally taken at 68°, at which strings, wind, organ and piano should be in tune. According to my coefficient A=435 at 59° should be A=438·93 at 68°. The round number 439 is more convenient. Briefly expressed, my coefficient is ·5 per degree for C=500; nearly, if not quite, the rise in free air. According to Helmholtz, the velocity of sound in dry air is at 0° C. (32° F.) 322 metres = 1089·3 feet, say 1090; according to Dr. Ellis, at 60° F. the velocity is 1200 feet per second; with this my coefficient practically agrees. In further justification, I quote the Covent Garden A=440; the same vibration number for pianos, communicated to me by Herr Seuffert (Bösendorfer's), Vienna; the clarinet of Herr Mühlfeld, of Meiningen and Bayreuth, A=439·5, it being understood when warm; a complete trial of all the wind instruments of Mr. Henschel's orchestra with a piano tuned to A=439 in a room exactly at 68° F.; and lastly, the crowning triumph of the Lamoureux orchestra from Paris joining forces with the Queen's Hall orchestra in London this year, the accuracy of pitch in the performance being unassailable, A = 439! I should like to add for organs my trials of the St. James's Hall organ, at 52° C = 531 and at 72° C = 541, as one of many comparisons of this nature; and conclude with Prof. Blaserna's report of a trial at Vienna, 1885, when A = 435 at 15° C., warmed to 30° C., became A = 457·7, equivalent to raising A to a tempered B flat. If a piano were supplied for a concert intended to be French pitch, at the standard fork A = 435, in London or Paris, Berlin or Vienna, it would be too flat for performance. It would be a concession of great importance, which the musical world could not be too grateful for, if the Paris diapason normal were revised for the higher temperature, 20° C., and legalised A.D. 1900, for France at A = 439. Our Philharmonic Society has shown the way, the rest of the world would soon follow. Neither the stability of pitch of the tuning-fork nor that of a pianoforte during a concert need be considered. Dr. Ellis gives the flattening of tuning-fork as 1 in 16,000 per degree Fahrenheit; Mr. Blaikley and myself in one trial only of a concert pianoforte, ·025 per degree; but for the short time a concert lasts this must be imperceptible, the elasticity of the music wire having to be reckoned with against the least change of tension.

The objections to the A = 439 that have been urged are that wind instrument makers may take it as a starting point for a lower temperature than 68°, but not if they are conscientious? We can legislate for this no more than we can for the tendency to exceed the present high pitch, as is shown by our military bands and the majority of the brass bands in this country, in spite of Kneller Hall, which is bound to maintain the old Philharmonic pitch until the War Office releases the army from it and provides or sanctions French pitch bands. Organ-builders who can work with accurate forks and a thermometer will have no difficulty with the French pitch—indeed, nearly all are in favour of it, as are the pianoforte-makers and dealers generally, but there are some who seem to fear their instruments will suffer in brilliancy of effect by the reduction. When, however, we consider the rise in the tension of pianos during the last thirty years, due to improvement in music wire and to a great change of construction, causing in grand pianos a rise in tension equivalent to a minor third in pitch, or more; and when we reflect that the difference of pitch proposed in tuning to the new Philharmonic is only 3/5 of an equal semitone, we may see in the change more a gain than a loss by a possible increased fulness of tone-quality, and above all we shall have uniformity with the rest of the musical world.

A. J. HIPKINS.

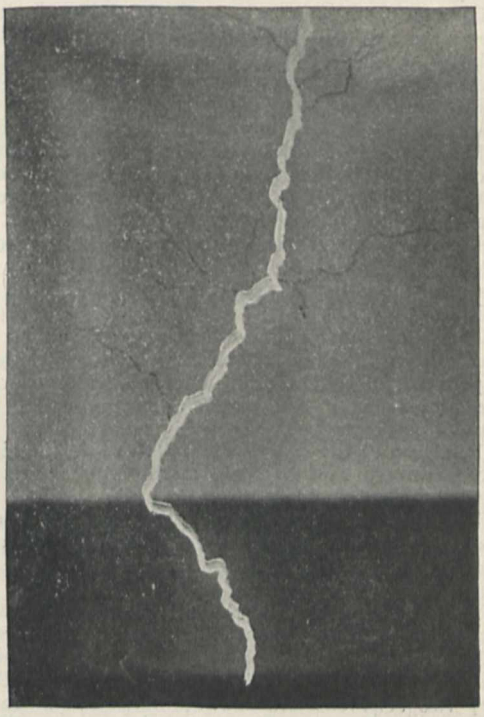
RIBBON AND DARK LIGHTNING.

MR. ALEX. MORTON, secretary and librarian of the Royal Society of Tasmania, has sent some photographs of lightning flashes taken by Mr. W. Aikenhead, one of which is here reproduced. The photographs were taken at night with a hand camera. Referring to them, Mr. Aikenhead remarks :—"The thunderstorm was an unusually severe one, and the atmosphere surcharged with electricity, as evidenced by the frequency and extraordinary vividness of the lightning flashes, whose brilliancy momentarily rendered objects, even at a distance, as clearly discernible as in daylight. The intensity of the 'triple' flash—of which I was so fortunate as to secure a counterfeit—was so great that for some moments I was completely dazzled. I may mention that the thunderstorm lasted fully an hour, and was at its height about 9 o'clock ; and it was at this period the exposures were made with my camera."

The accompanying picture is interesting on account of the triple flash represented in it, and the dark lines apparently radiating from it. In an article printed in NATURE several years ago (vol. xlii. p. 151, 1890), Mr. Shelford Bidwell described each of these characteristics of photographs of lightning flashes, and gave explanations of them. He remarked that in nearly, if not quite, every case where broad ribbon lightning has been photographed, the camera was held in the operator's hand—a fact which naturally suggests the idea that the widened image of the flash may be due to the movement of the camera during exposure. Though it might be impossible to move the camera appreciably in the brief duration of a single lightning flash, several flashes sometimes pass in quick succession over the same path, so that they may appear side by side upon the photograph if the camera is shifted during their occurrence. Moreover, Mr. Bidwell pointed out that lightning sometimes leaves a kind of phosphorescence along its track, and this may last long enough to produce a photographic picture, even though the flash itself was instantaneous. A photograph of a triple lightning flash reproduced in NATURE of October 13, 1898 (vol. lviii. p. 570) furnishes decisive evidence that a camera can be moved quickly enough to obtain several pictures of a single luminous track of lightning. The three flashes shown in that picture are identical in shape, and it is estimated that they followed one another along the track with a frequency of about 30–35 per second.

But while it is certain that some photographs of multiple and ribbon lightning are produced by movement of the camera, others represent actual lightning of a broadened or multiple form. Commenting upon some photographs of ribbon lightning obtained by the Rev. J. Stewart-Smith, Prof. Cleveland Abbe remarked in the U.S. *Monthly Weather Review* of August 1898 that he thought that they were not taken by moving the camera during exposure. He considered that a discharge of lightning was too fleeting to be influenced by the motion of the camera. With artificial oscillatory discharges the time of the discharges and the motion of the sensitive film might be so controlled as to produce the appearance of a ribbon ; but no motion of the camera seemed likely to explain the many details in the ribbon photographs of natural lightning described. Prof. Abbe thought, however, there was one flash on Mr. Stewart-Smith's plate that had every indication of being certainly an oscillatory discharge, showing lines of flow identical with those photographed by Prof. Trowbridge at Cambridge, Massachusetts, and fully maintaining his conclusion that the lightning flash is an oscillatory discharge repeated frequently to and fro within the crack in the air that is opened by the first discharge.

That lightning flashes can actually present a ribbon-like appearance, and have an appreciable duration, is borne out by a letter which was sent to the Royal Society from Buluwayo at the end of 1895, and was printed in NATURE of January 23, 1896 (vol. liii., p. 272). The writers state that they were sitting in a room when one of them called attention to a very bright lightning flash. "All of us promptly went to the door, whence we witnessed a truly extraordinary sight in the shape of three ribbons of a greenish-white lightning, which hung in the sky, motionless, for what must have been fifteen to twenty seconds. It seemed to be a long way off (in a north-westerly direction), as we heard no report of thunder whatever. There could be no mistake about it —it was as distinct as possible, and it must have lasted fifteen seconds *at least*." With evidence of this kind to consider, the reality of the ribbon appearance cannot be doubted. To obtain more definite information concerning this form of lightning and the nature of the electric discharge in an ordinary lightning flash, systematic attempts should be made to photograph lightning with cameras having a known rate of movement, and an



Photograph of lightning taken at Davonport, Tasmania, by Mr. Aikenhead.

arrangement for determining the angular diameter of the ribbon.

As to the dark ramified flashes shown upon the accompanying picture, Mr. A. W. Clayden has shown by experiment that they are due to photographic reversal. If the lens of a camera is covered up immediately a flash has been photographed, the flash comes out bright in the ordinary way in the print ; if, however, the lens is allowed to remain uncovered for a minute or so, thus exposing the plate to the diffused light of the sky or the glare of other flashes, the original flash appears black upon the final print.

In the same way, the discharge of an electrical machine can be made to appear dark in a photograph by leaving the lens uncovered for about a minute after the discharge has imprinted itself upon the plate. According to this, the dark ramifications in Mr. Aikenhead's picture represent a discharge of lightning which occurred before the bright triple flash. The glare of the bright flash and the

diffused light of the sky caused the photographic reversal of the first image.

Photography thus gives no support to the view that dark lightning has a real physical existence; and Lord Kelvin's letter printed in NATURE of August 10 (p. 341), together with that by Dr. W. J. Lockyer in last week's number, show conclusively that when it is visually observed it is an effect due to fatigue of the retina.

THE RECENT ERUPTION OF ETNA.

PROF. A. RICCO, Director of the Etna Observatory, informs us that on July 19, at 8 a.m., Mount Etna threw out from its central crater an enormous mass of vapour, stones, lapilli, and cinders, which were lifted to a height of several kilometres, and afterwards covered all the south-east slope of the volcano as far as Zofferana Etnae (altitude 600 m.), where the roads are covered by nearly a centimetre of volcanic ash. A number of stones struck the dome of the Etna Observatory (which is about a kilometre from the central orifice), so that about thirty holes were made in the iron plates, six millimetres in thickness, which cover this dome; five of these holes have a diameter of 30 centimetres, and the stones causing them fell into the observatory containing the refractor. Two stones also pierced the floor, and embedded themselves in the basement; and one broke three steps of the observing chair. Another pierced the wooden base surrounding the foot of the refractor; fortunately, this and the other apparatus of the observatory received no damage. Two other stones passed through the roofs of the side-rooms.

Round the observatory there are about fifty holes, caused by the fall and penetration of the stones in the sandy soil.

A heap of straw which was near the stables of the observatory was reduced to ashes, which proves the high temperature of the eruptive materials; moreover, holes were also burnt in the wooden flooring where it had been pierced by stones.

The steam of the eruption condensing in the air gave place to a warm and acid rain in the higher parts of the volcano, and lower down it caused ordinary rain.

The column of steam had by nine o'clock spread itself enormously in the sky nearly over Catania (a distance of 30 km.), and caused a marked darkening. By 9.30 the column had disappeared.

The eruption was accompanied by no perceptible movement of the earth, except a slight shock at the lower end of the Valle del Bove. The instruments at Catania only indicated a very slight oscillation. At the Etna Observatory two seismometers showed horizontal and vertical movements. The eruption was also accompanied by detonations, which were heard very slightly as far as Catania.

On July 25 there occurred a similar eruption, but of less importance.

PROFESSOR BUNSEN.

ON Wednesday morning, August 16, the illustrious Heidelberg chemist breathed his last, after a long life wholly devoted to the furtherance of science. In April 1881 I communicated to the columns of this journal a sketch of the work of him whose death at the ripe age of eighty-eight all lovers of science now have to deplore. We can only now call attention to the magnitude and extent of that work, and lay on the grave of one of the truest and noblest of men the tribute of our admiration and respect. As expressing the position held by Bunsen amongst the standard-bearers of science, I may, perhaps, be forgiven for quoting the opening sentences of what I wrote eighteen years ago, as I cannot find more appropriate words to indicate what all feel who know what his work was.

"The value of a life devoted to original scientific work is measured by the new paths and new fields which such work opens out. In this respect the labours of Robert Wilhelm Bunsen stand second to those of no chemist of his time. Outwardly the existence of such a man, attached, as Bunsen has been from the first, exclusively to his science, seems to glide silently on without causes for excitement or stirring incident. His inward life, however, is on the contrary full of interests and of incidents of even a striking and exciting kind. The discovery of a fact which overthrows or remodels our ideas on a whole branch of science; the experimental proof of a general law hitherto unrecognised; the employment of a new and happy combination of known facts to effect an invention of general applicability and utility; these are the peaceful victories of the man of science which may well be thought to outweigh the high-sounding achievements of the more public professions."

In the columns which follow the above will be found a statement of the chief experimental researches which have not only raised Bunsen by the common consent of all who can understand the results of accurate and far-reaching methods to the highest point of scientific honour, but also of those more popular discoveries which have made his name a household word in circles far wider than those of purely scientific appreciation. Now, therefore, it is only necessary to recall the main facts of his life work; to note, in the first place, that his desire to unravel the secrets of nature was unalloyed by any attempt to make capital out of any application of his discoveries. "To one man," he often said, "comes the duty of discovery, to another that of applying that discovery to practical uses." Like our great countryman Faraday, Bunsen consistently refused to be drawn away from the paths of purely scientific investigation, and, though too clear-sighted a mind to belittle the importance of the application of scientific discovery to every-day life, rightly judged that to him belonged the undoubtedly higher and nobler work of enlarging the boundaries of knowledge.

The next thing to be noted about Bunsen's work is its originality and its accuracy. It matters not whether we look into his purely chemical investigations, at his chemico-geological researches, or at those—perhaps the most remarkable amongst the many questions he answered—which lie on the borderland of physics and chemistry, in every case we rise from the study not merely feeling that we have to do with a master's mind and hand, but that each investigation is stamped by an original mode of treatment and by an accuracy of thought and of manipulative power which, it is not too much to say, has rarely if ever been equalled.

In no instance was this rare combination of mental and manual dexterity more strikingly shown than in his investigation of the compounds of cæsium, the rarest of the two alkali metals which he discovered by means of spectrum analysis. In order to prepare the pure salts of this metal, some scores of tons (I write this away from books, and therefore cannot give the exact figures) of Dürkheim mineral water had to be evaporated, and from this residue it was only possible to obtain some five or six grams of the pure chloride. Nevertheless, from this comparatively minute quantity Bunsen succeeded not only in preparing and analysing all the important salts of cæsium, but in ascertaining by goniometric methods their exact crystalline form. So that he was able to supply all the information requisite to a complete understanding of the position of this new element and its compounds to those of its well-known relations potassium and sodium.

Then look at his gasometric methods. He was the first to attempt anything like exactitude in the measurement of

gases. And when he had perfected his methods, no improvements as regards accuracy were forthcoming. Other quicker and, perhaps, more handy processes have since come into vogue; but it was Bunsen who taught men how to handle and to separate and measure gaseous substances.

Next take his researches in chemical analytical methods. There we find again that all he touches he adorns. Whether in the delicate and complicated silicate analyses, in blow-pipe work and flame reactions, in volumetric methods, in separations of closely allied metals, such as antimony and arsenic, or those of the cerite earths, we see the same master's touch. Then his physico-chemical researches, his ice-calorimeter, his photo-chemical investigations, about which I am able to speak with special authority; his methods of ascertaining the specific gravity of gases by their rates of diffusion, and many other distinct lines of research, all well known and recognised as classic, exhibit the same wonderful power.

About his more popularly-known discoveries it is not necessary here to speak, save to say that the Bunsen battery and the Bunsen burner have rendered his name a household word all the world over, whilst his application of spectrum analysis to the investigation of terrestrial matter has done more than all the investigations of past time to increase our knowledge of the chemical composition of the earth's crust.

But this experimental work, great and important as it is, is not the greatest or most important work which he accomplished. It is as a teacher and as an example that the name of Bunsen is and will be chiefly honoured and remembered. It is only those who have had the benefit of working under and with him who can fully understand the feelings of affection and respect with which they regard his memory. To those who had the privilege of his intimacy, of whom I can happily lay claim to be one, his friendship will remain as an abiding source of gratification. As an investigator he was great, as a teacher he was greater, as a man and a friend he was greatest.

HENRY E. ROSCOE.

NOTES.

THE Royal Society has received through Mr. Chamberlain the following memorandum by the Governor of the Straits Settlements:—

The Government of the Straits Settlements desires to invite the attention of Radcliffe's travelling Fellows, and of holders of scholarships for medical and physical research, to the study of the tropical disease called Beri-beri. This disease caused in the hospitals of the Colony 730 deaths in 1896 and 692 in 1897. This Government will be glad to assist any scholar who desires to engage in the scientific investigation of this disease in the Colony by providing him with furnished quarters, rent free, by giving him free access to all the hospitals and facilities for studying the cases therein, by defraying the cost of his passage to the Colony, and in any way which may be agreed upon hereafter between the scholar and the undersigned.

By Command of the Governor,
J. A. SWETTENHAM,
Colonial Secretary, S.S.

Colonial Secretary's Office,
Singapore, July 20.

It may be added that Dr. Hamilton Wright, late of Montreal, has recently been appointed pathologist to the Straits Settlements. He will be provided with an adequate laboratory, on the furnishing of which he is now engaged. The opportunities for pathological research will therefore be extremely good.

THE eighteenth annual Congress of the Sanitary Institute was opened at Southampton on Tuesday, when about seventeen hundred delegates attended. Sir William Preece, K.C.B., the president, delivered his inaugural address, in which he dealt with the principles underlying practical applications of sanitary engineering.

MR. A. H. MILNE, hon. secretary of the Liverpool School of Tropical Diseases, informs us that in response to a request from Major Ross that workers should be sent out to join him at Sierra Leone, the school is despatching, as an assistant to him, Dr. R. Fielding Ould, of the Liverpool School of Pathology, who has had special experience in private bacteriological research. It is to be hoped that the Government will take the matter in hand, and will help the work of the expedition.

WE learn from *Science* that Dr. A. B. Meyer, Director of the Dresden Museums, is now in the United States on a commission from the Saxon Government to inspect American museums before the new buildings are erected at Dresden. He is accompanied by Prof. P. Wallot, who is one of the international commission of architects selected to decide on the plans of the University of California in accordance with Mrs. Hearst's arrangements.

A *Reuter* telegram from Potsdam states that the new observatory and the great refractor, recently erected at the Astrophysical Observatory there, were inaugurated on Saturday, August 26, in the presence of the German Emperor.

OUR photographic readers may be reminded that all entries for the Royal Photographic Society's forty-fourth annual exhibition, to be held at the Gallery of the Royal Society of Painters in Water Colours from September 25 to November 11, close on Wednesday, September 6, at 9 p.m.

THE Allahabad *Pioneer Mail* states that an Austrian scientific party will visit India towards the latter end of October to observe the display of Leonid meteors which will take place in November. Two observation stations are to be fixed at Delhi, some five miles apart, telephonic communication being maintained under arrangements made by the Telegraph Department.

DR. A. CANCANI, formerly assistant at the geodynamic observatory at Rocca di Papa, has been selected to succeed Dr. G. Agamennone as assistant in the central office of meteorology and geodynamics at Rome. Dr. Cancani is well known to seismologists for his work in connection with the velocity of earthquake-waves, and for the improvements which he has made in the pendulums designed for recording the undulations from distant earthquakes.

REFERENCE has already been made to the fact that the section of the tree under which Dr. Livingstone's heart was buried, containing the inscription carved by his followers, has been obtained for preservation in the Royal Geographical Society's collection of relics. The *British Central Africa Gazette*, published at Zomba, gives the following particulars of the journey to obtain the section:—Mr. Codrington, Deputy Administrator for the British South Africa Chartered Company north of the Zambesi, left Fort Jameson (Mpezeni's) on April 24, and reached Chitambo on May 9. From the present village of Chitambo he travelled with Chitambo ten miles E.S.E., three miles to the Msumba river or swamp, and then seven miles to the Luwe river. These streams flow into the Lulimula river, and that into the Luapula. Chitambo states that his father was interred under the *Mpundu* tree close to the spot where Livingstone's heart was buried. The following measurements were taken of the tree: Round base, 13 feet 5 inches; round bottom of inscription, 10 feet 1 inch; round top of inscription, 10 feet; height of bottom of inscription from ground, 4 feet 5 inches. The bark was cut off by Livingstone's men in order

to enable the inscription to be carved, and it has now grown over part of the letter "E" in Livingstone and over the number "3" in 1873. Livingstone's *Mpundu* tree was too old to give seeds, so it was not possible for Mr. Codrington to bring away any of these. After the tree had been cut down, and the section containing the inscription carefully removed, a tall iron telegraph pole was erected in the entre of the stump and carefully secured. This, together with the various observations taken, will suffice to mark the exact spot until a suitable monument may be erected. The altitude (by boiling point) at the *Mpundu* tree was found to be 3877 feet above sea level.

MR. W. WELLMAN and the American members of his polar expedition arrived at Hull on Tuesday from Tromsö. In addition to the information published in last week's NATURE (p. 399) concerning the results of the expedition, the following particulars were given by Mr. Wellman to a representative of Reuter's Agency:—"The point at which we turned back was about twenty-five miles north-west of the Freeden Islands, where Dr. Nansen landed in 1895, and north of these islands we saw and took the bearings and photographs of three islands and a large land, none of which had been seen by either Payer or Nansen. We were also able wholly to clear up the mystery of Payer's so-called Dove glacier, which simply does not exist, as Dr. Nansen had in part shown. In addition to this useful geographical work, greatly augmented by subsequent journeys under Messrs. Baldwin and Harlan, these two gentlemen and Dr. Hoffmann, the naturalist, did some valuable scientific work which will, I feel sure, attract much attention when elaborated and reported in proper form. I still believe it possible to reach the North Pole by Franz Josef Land, but whether or not I shall make another effort in that field I am unable to say." After Mr. Wellman's return to headquarters on April 9 Mr. Baldwin again took the field, leaving camp on April 26, accompanied by the four Norwegians, this party having twenty-six dogs and two sledges, carrying provisions for three weeks. Their object was to examine the unknown region to the eastward of Wilczek Land. They were enabled to chart the entire eastern as well as north coasts of that land. Thirteen miles further east they discovered a large ice-covered island nearly as large as Wilczek Land and extending to 64° E. longitude. Several smaller islands were also discovered during this journey. The newly-discovered land was named Graham Bell Land, after the president of the National Geographical Society of America. Another exploring journey was made by Mr. Harlan, and later a trip by steamer, the result being a fairly complete survey of the unknown and unmapped parts of the archipelago.

THE practical application of the Röntgen rays to the needs of medicine and surgery formed the subject of the presidential address recently delivered before the Röntgen Society by Dr. C. M. Moullin. There is no branch of medicine or surgery which does not afford abundant evidence of the improvements which have taken place in the production and utilisation of the Röntgen rays in the course of the past year. Dr. Moullin points out that the fluorescent screen has now reached such a degree of perfection that with suitable apparatus the minutest movement of the heart and lungs, and the least change in the action of the diaphragm, can be watched and studied at leisure in the living subject. In short, Dr. Moullin testifies that there is scarcely any change in connection with the lungs and the heart and great vessels which cannot now be seen and photographed, scarcely a disease of the chest or of the organs which it contains concerning which the most valuable information cannot be obtained. To such an extent has the fluorescent screen been improved, and so easy has investigation with it been made, that it is probable that some day the examination of a patient's chest with it will be considered as much a matter of routine and as little to be neglected in all doubtful cases as an examination with the stethoscope is at the present time. Valuable as are the indications given by the ophthalmoscope in obscure diseases of the brain, they are not to be compared with those which can be obtained by systematic and skilled use of the fluorescent screen in diseases of the heart and lungs.

THE benefit which surgery has derived from the improvements which have been effected in the use of the Röntgen rays during the past year is, Dr. Moullin states, no less striking than that gained by medicine. As might be expected, the largest proportion and the most striking cases have been furnished by the injuries and diseases of bones and joints. With a well-lit fluorescent screen the nature of an injury can be seen at once, and, what is even more valuable, it is no less easy to ascertain whether a fracture is properly set or a dislocation completely reduced. If the screen is of service to physicians in the diagnosis of intra-thoracic disease, the records of the past year have shown by numberless instances that it is no less valuable to surgeons by enabling them to make sure at a glance that the bones are in their proper relative situation without touching the splints or giving the patient a moment's pain. So far as surgery is concerned, Dr. Moullin remarks, nothing illustrates the immense improvement which has been made in radiography in the course of the past year better than the detection of renal calculi. Until this year the instances in which they had been photographed and verified by operation were few and far between. Now, thanks more particularly to the work of Mr. Mackenzie Davidson in this direction, the detection of renal calculi can be looked forward to with a fair degree of certainty, and, what is even more valuable, as saving patients from unnecessary operation, the evidence can be trusted equally well when it is negative. In all ordinary cases it may be said that if no calculus is seen there is no calculus there to see.

FROM reports in the *Agricultural Journal*, published by the Cape Department of Agriculture, it appears that much success in exterminating locusts by inoculation with the locust disease fungus has been attained in many districts. The fungus is prepared and supplied by the Director of the Bacteriological Institute, Graham's Town, at a cost of sixpence per tube to all applicants residing in Cape Colony. One of the reports upon its use states that over a hundred locusts which were inoculated with fungus disease were distributed amongst a swarm, and on the next morning and the following days large numbers of dead ones were in the sand dunes, being killed by the fungus, as microscopical examination and further experiments with the bodies proved. The growth of fungus from the dead locusts produced a fungus more rapid in growth but smaller in size than the Government fungus. In another case, the fungus was mixed in lukewarm water, and young locusts were released after immersion in the liquid. After three days rain fell, and on the afternoon of the fourth day locusts were found in heaps in the bushes about three miles from where they were immersed. Districts in which no such measures are being taken are much more infested with locusts than those where the fungus treatment is adopted.

SEVERAL articles and notes upon india-rubber and the india-rubber industry in various parts of the world are contained in Nos. 147-150 of the *Bulletin* of the Royal Gardens, Kew, just published. A paper by Prof. Tilden on the spontaneous conversion of isoprene into caoutchouc is reprinted, and it is pointed out that the result represents a step towards the artificial production of india-rubber commercially. Prof. Tilden has not yet been able to bring about this change at will. His observations show that the polymerisation proceeds very slowly, occupying several years, and all attempts to hurry it have resulted in the

production, not of rubber, but of colophene—a thick sticky oil, quite useless for all the purposes to which rubber is applied. The *Bulletin* publishes correspondence showing how the falling off in the production of rubber at Lagos is due to the reckless way in which the trees have been exhausted. The rubber is collected from the Ire tree (*Kickxia africana*), and has been an important source of wealth to the Colony; but the industry is rapidly decreasing, owing to want of control over the collectors who tap young trees, and destroy rubber forests by over-working. In Madagascar efforts are now being made to establish plantations of rubber-producing plants. The island has long been known to furnish a supply of india-rubber to commerce, the rubber being obtained until a few years ago from species of Landolphia—the rubber-vines, which are so widely distributed in tropical Africa. About 1892 another source of rubber was exploited, but unfortunately both the trees and shrubs producing rubber have been ruthlessly destroyed, and it is necessary to take active steps to cultivate rubber plants to preserve the industry. The May and June *Bulletin* contains correspondence which indicates the actual source of Peruvian india-rubber. According to the information received, the Caucho tree of Peru is a Castilloa.

Bulletin, No. 56 (April 1899), of the West Virginia Agricultural Experiment Station, Morgantown, consists of a report on investigations to determine the cause of unhealthy conditions of the spruce and pine from 1880–1893. This is one of the admirable series of reports which are now issued regularly in many parts of the United States, in order to cope with the immense destruction wrought by insects in that country, resulting, during the fourteen years mentioned above, "in the death and total loss of many hundred thousand dollars' worth of the finest timber in the State" of Virginia. Entomology is no child's play in the States, and Prof. Hopkins enumerates 197 species of insects, observed by himself as infesting the spruce and pine, about half of which are injurious, the remainder being beneficial as parasites of the destroyers, or indifferent. These belong to all orders of insects except Orthoptera, and we imagine that a careful search would be able to fill up this gap by the discovery of some Blattidæ, at least, under loose bark, or in similar situations. Most of the mischief, however, is done by wood-boring beetles, of which, and of their curious burrows, many illustrations are given. There is also an illustration of a portion of a black spruce tree eight inches in diameter, which had been slightly injured, when a colony of large black ants (*Camponotus pennsylvanicus*) took possession, and hollowed out the trunk till the heart-wood was completely destroyed, and the tree fell. This report should be of great interest both to entomologists and foresters, for our own conifers are liable to the attacks of a large number of insects congeneric with many of those here mentioned, though others (as for instance *Camponotus*, just referred to) do not inhabit this country.

IN the U.S. *Monthly Weather Review* for May, there is a useful summary of the climatology of the Isthmus of Panama, by Brigadier-General H. J. Abbot. The first Panama Canal Company made daily observations at Colon, Gamboa and Naos during the years 1882–7, from which it is seen that the temperature differs very slightly during the year. At Colon the mean of the absolute maximum temperature varies from 89°·6 in February to 91°·9 in October; and the absolute minima from 68°·4 in January and April to 70°·5 in October. At Gamboa the absolute mean maximum was 97°·5 in June, and the minimum 59°·4 in February; and at Naos these means were respectively 96°·3 in June and 66°·7 in March. Throughout the whole Isthmus the rainy season begins with May; owing to the northward advance of the layer of rising air, a diminution takes place in July, in the interior, but is subject to the delay of one month on the Pacific side and of two months on the Atlantic side. A second maximum occurs at the end of September in the interior, but at the end of October on the Pacific coast and in the middle of November on the Atlantic coast. Then comes the dry season, which begins everywhere about January 1, and continues for four months. The mean annual rainfall is 120 inches on the Atlantic coast, 93 inches in the interior, and 62 inches on the Pacific coast. Although the rainfall is large, it is comparable with the amounts registered in the United States near the Gulf of Mexico. The paper contains a number of fragmentary observations referring to other periods, for which hourly or monthly variations from mean values have been calculated.

WE have received from the Observatory of Manila, of which the director is Father J. Algué, S.J., a volume (pp. xvi + 192, 4to) entitled "Las nubes en el Archipiélago Filipino." The observatory was one of the institutions invited by the International Meteorological Committee to take part in the special observation of clouds during a year ending May 1897. The volume in question, owing to delay in preparation of the necessary instruments, contains results from June 1, 1896, to July 31, 1897. The work is divided into two parts, giving (1) an account of the principal nephoscopes and theodolites in use, and the results obtained in the Philippine Islands by means of some of them; and (2) an explanation of the methods used in the photogrammetric measurements of the heights and velocities of the clouds, and the valuable results obtained at the Manila Observatory. The volume also contains an interesting account of the importance of the observation of the movements of upper clouds for the purpose of storm prediction.

THE "Eight Queens Problem" is the problem of finding the different ways in which eight queens might be arranged on a chess-board so that no two should be in check of each other; in other words, the number of ways of arranging eight pieces so that no two shall be in the same row, column, or line parallel to a diagonal. This problem, which has occupied the attention of Nauck, Gauss, Günther, Glaisher, Rouse Ball, and Pein, forms the subject of a paper by Dr. T. B. Sprague in the *Proceedings* of the Edinburgh Mathematical Society. There are ninety-two solutions, but these are not all independent, for in general each solution gives rise to four altogether by simply rotating the board, and this number is doubled by taking the reflections of these in a mirror, the exception to this rule being when the pieces are symmetrical about the centre. Mr. Sprague considers the general problem for a board of n^2 squares. This problem was reduced to one in determinants by Günther and Glaisher, thus: if a determinant is constructed in which terms in lines parallel to one diagonal are represented by the same letter, and those in lines parallel to the other have the same suffix, the solutions are the terms of the determinant in which no letter or suffix occurs twice. The solutions for squares with one to ten squares in a side were given by Pein, and the ten-sided square possesses 724 solutions. Mr. Sprague has now given the solutions for an eleven-sided square, which are 2680 in number, but he considers it would be necessary to obtain the co-operation of a number of persons in order to classify the solutions for larger squares.

VERY little has hitherto been recorded in regard to the life-history of those peculiar North American rodents locally known as Sewellels, and scientifically as *Haplodon*. It is therefore satisfactory to have a description of the habits and environment of one of the species, from the pen of such an accurate observer as Dr. D. G. Elliot, in the March issue of the *Publications* of the Field Columbian Museum. The Sewellels, which constitute a somewhat isolated family by themselves, are animals of the size of a small rabbit, but with a more beaver-like appearance

and coloration, although short-tailed. The species inhabiting the Olympic Mountains is known to the natives as the "Mountain Beaver," or "Farmer," the latter being the title most commonly employed. Retiring in its habits, it keeps to wet and swampy places in the neighbourhood of small streams, making its burrows in the banks of the latter. Although when in the bushes its movements appear to be exceedingly quick, yet when in the open it is rather slow. These animals obtain their name of "Farmer" from their habit of making "hay." They usually excavate their burrows in the vicinity of a certain water-plant, apparently a kind of low-growing water-lily. The stems and leaves of this plant the little rodents cut down in large quantities and convey to the mouths of their burrows, where, after being spread out to dry in the sun, they are finally carried into the interior to be used as food and bedding.

IF the history of "type specimens," on which museum curators now set so much store, were written, portions of it would read almost like a romance. A case in point is afforded by Dr. Jentink's account of the rediscovery of the type of the peculiar Malagasy carnivore *Fossa daubentoni*, published in *Notes of the Leyden Museum* for October last. In 1872, Gray, after searching the Paris Museum, came to the conclusion that the type described by Schreber was irretrievably lost. Subsequently, however, an imperfect skull turned up in the Paris Laboratory of Comparative Anatomy, which it was thought might belong to the missing specimen. And now Dr. Jentink has discovered in the Leyden Museum a skin with a cast of the Paris skull placed in it, which is undoubtedly the long-lost specimen. It is stated to have been received from Paris in 1835, and appears to be one of the results of an exchange effected by Temminck and Schlegel, who visited the Paris Museum in that year. Incidentally Dr. Jentink shows that "Fossa" is the proper native name of the animal in question, and that it is not applicable to the *Cryptoprocta ferox*, of which the Malagasy title is "Farassa." This alteration should accordingly be made in our text-books.

IN the July and August numbers of the *Zoologist*, the editor, Mr. W. L. Distant, gives the first two instalments of what promises to be a very interesting discussion on "mimicry." Till the communication has reached a more advanced stage, it will obviously be impossible to learn the author's general views on a very difficult and very important subject; but it may be noted that he intends to divide the alleged cases of mimicry into those considered as "demonstrated" and those classed as "suggested or probable," after which we may expect a fuller discussion on the whole subject. In the first section of his communication Mr. Distant takes up the case of the Stick-Insects (*Phasmidae*), and discusses their bearing on the mimicry theory. These insects, he states, are usually considered as undoubted examples of protective resemblance due to natural selection. If, as has been asserted, they are represented in the Carboniferous, they must be the result of an antecedent evolutionary process. Further, the presence of imitative *Phasmidae* in the Carboniferous implies the existence of enemies, probably reptiles, and possibly transitional forms of bird-life. Thus mimicry must be of very ancient origin; whence it is argued that some cases of it in existence without any apparent reason may be due to survival, and are now altogether useless to the animals in which they occur. The alleged protective resemblance of fishes to their surroundings is, the author suggests, not the true explanation of their colouring, their extraordinary fecundity being, in his opinion, sufficient to override the necessity for any such protection. We shall await with interest further instalments of this communication.

IN the August number of the *Zoologist* a discussion is being raised as to the manner in which the helpless and shapeless new-born young of the kangaroo is transferred to the materna pouch and affixed to the nipple from which it is to derive nutriment. Some have said that it is carried in the paws of its female parent, while one asserts that the transference takes place by the aid of the lips, and that it has been actually witnessed in the Zoological Gardens. This, however, we gather from Mr. E. Bartlett's communication, is not the case. It ought to be possible to decide the point by actual observation in a menagerie.

THAT the Edinburgh Geological Society, under the presidency of Mr. John Horne, is in a flourishing condition is manifest from the record of its *Transactions*, of which we have lately received Part 4 of vol. vii. for 1899. Mr. J. G. Goodchild contributes a short and appreciative memoir of the late Prof. Heddle, with a portrait of that distinguished mineralogist. This article is followed by a short paper, which was read before the Society in 1856, by Heddle, and not previously printed; it deals with the minerals of the Storr, near Portree. There is a useful paper on the subdivisions of the Carboniferous series in Britain and their European equivalents, by Dr. Wheelton Hind, who shows to what extent at present he has been able to subdivide our rocks into palæontological zones. Mr. William Gunn discourses on the Lower Carboniferous rocks of England and Scotland. Mr. Herbert Kynaston contributes notes on the petrology of the Cheviot Hills; and there are various other papers of local interest. A short article by Mr. E. Greenly on the Hereford earthquake of 1896 might more appropriately have been printed in the *Transactions* of a Welsh or West of England Society, as it deals with the relations of this disturbance to geological structure in the Bangor-Anglesey region.

A REPORT on the surface geology and auriferous deposits of South-eastern Quebec has been prepared by Mr. R. Chalmers (Geol. Survey of Canada, Part J, *Ann. Rep.*, vol. x.). The author has devoted particular attention to the glacial and other superficial deposits in the St. Lawrence valley, as it is chiefly in these that gold is found in workable quantities. The primary source of the gold is traced to the crystalline schists of Pre-Cambrian or Huronian ages; schists which were invaded by diorites and other intrusive rocks, and which afterwards yielded materials to the basal Cambrian conglomerates and later deposits. In these Cambrian and Silurian rocks much gold would have been disseminated in a fine state of division. After the consolidation of these rocks, upheaval, crumpling, faulting and metamorphism would seem to have taken place; and Mr. Chalmers thinks that the gold was probably brought up in solutions and concentrated along with silica and the metallic sulphides in faults and fissures, thus forming auriferous veins. Much gold was long afterwards distributed in superficial deposits during pre-Glacial times in ancient river-beds; and these deposits and the material of old weathered surfaces of the crystalline rocks have been partially removed and redeposited time after time during the changes of Glacial and post-Glacial times.

WE have received the general report on the work carried on by the Geological Survey of India during the year ending March 31, 1899, under the direction of Mr. C. L. Griesbach. Field-work has been carried on in the Raipur district, in South Rewa, and in Western Rajputana; and after many years' intermission the geological survey of the higher ranges of the Himalayas has been resumed. Trilobites of the family *Olenidae* have been found in the Upper Haimantas slates, showing that they are probably of Upper Cambrian age. The occurrence of Ammonites (*Xenodiscus* and *Arcestes?*) is noted in the *Productus*-shales of Carboniferous age. Field-work has also been carried on in Baluchistan, where Jurassic, Cretaceous, and Tertiary strata have been mapped. In the Cretaceous system,

zones of *Gryphaea vesicularis*, *Radiolites*, *Ostrea acutirostris*, &c., are noted. Economic geology rightly received considerable attention, and the mineral Mica was selected for special study. Records are also given of the important work done in the Laboratory and in the Palæontological Department.

THE fourth edition of "Remarkable Eclipses," by Mr. W. T. Lynn, has just been published by Mr. Edward Stanford. Reference is made to the results of observations of the Indian eclipse last year, and to the eclipse which will occur on May 28, 1900. The central line of this eclipse will pass from America across Portugal, Spain and Algeria.

THE tenth annual report of the Missouri Botanical Garden has recently been published. Dr. W. Trelease, the Director of the Garden, states that the collection of plants now includes more than eight thousand species and varieties, of which all but one or two hundred are named with more or less accuracy. Among the collections specially worthy of mention are the cacti, of which 462 species are cultivated; the orchids, represented by 548 named forms; the aroids, of which there are 274 species in the collection; the ferns, including 169 species; and palms, 61 species; while of hardy trees and shrubs there are 1811 species and varieties; of hardy herbaceous plants, 2179; and of vegetables, 1016. Roughly divided, the collection includes 5000 hardy forms, and 3000 cultivated under glass. The Herbarium comprises 307,460 specimens. Two scientific papers are included in the present report: one on the grasses in the Bernhardi Herbarium in the Missouri Botanical Garden, and another on a sclerotioid disease of beech roots. There is also a biographical sketch, by Prof. C. S. Plumb, referring to the late Dr. E. Lewis Sturtevant, whose gift of his extensive and valuable library of pre-Linnean works was an event in the history of the Garden; and a list of publications issued from the Garden in 1897 and 1898.

THE additions to the Zoological Society's Gardens during the past week include a Serval (*Felis serval*) from Africa, presented by Sir R. B. Llewellyn, K.C.M.G.; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. T. Mark Merriman; a Bonnet Monkey (*Macacus sinicus*) from India, presented by Mr. J. M. Skinner; a Spotted Ichneumon (*Herpestes auro-punctatus*) from Nepal, presented by Miss Jackson; a Red-faced Onakari (*Onacaria rubicunda*) from the Upper Amazons, a Red-vented Cockatoo (*Cacatua hoematuropygia*) from the Philippine Islands, deposited; two Lion Marmosets (*Midas rosalia*) from South-east Brazil, four Violet Tanagers (*Euphonia violacea*), three Blue-shouldered Tanagers (*Tanagra cyanoptera*), a Black-headed Sugar Bird (*Chlorophanes viridis*) from Brazil, a Black-necked Swan (*Cygnus nigricollis*) from Antarctic America, purchased.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN SEPTEMBER:—

September 4. 19h. Mercury at greatest elongation (18° 2′ W.).
9. 7h. Jupiter in conjunction with moon (☽ 4° 51′ N.).
12. 6h. Saturn in conjunction with moon (☽ 1° 55′ N.).
12. 8h. 47m. to 9h. 26m. Occultation of 39 Ophiuchi (mag. 6·0) by the moon.
13. 5h. 5m. to 6h. 9m. Occultation of 1 Sagittarii (mag. 5·3) by the moon.
14. 11h. 47m. Minimum of Algol (β Persei).
15. Mars. Illuminated portion of disc 0·967.
17. 8h. 36m. Minimum of Algol (β Persei).
19. 6h. 25m. Transit (ingress) of Jupiter's Sat. III.
23. 15h. 29m. to 16h. 25m. Occultation of A^1 Tauri (mag. 4·5) by the moon.

HOLMES' COMET 1899 *d* (1892 III.).—

Ephemeris for 12h. Greenwich Mean Time.

1899.	R.A.	Decl.	Br.	
	h. m. s.	° ′ ″	r^{-2}	$(r\Delta)^{-2}$
August 31	3 2 59·26	+40 1 26·8		
Sept. 1	3 37·68	40 16 1·8	0·1851	0·05219
2	4 14·34	40 30 31·8		
3	4 49·22	40 44 56·5		
4	5 22·26	40 59 16·0		
5	5 53·46	41 13 29 8	0·1833	0·05328
6	6 22·76	41 27 37·9		
7	3 6 50·14	+41 41 40 0		

SPECTRA OF RED STARS (SECCHI'S TYPE IV.).—In the *Astrophysical Journal*, vol. x. pp. 87–112, Messrs. G. E. Hale and F. Ellerman contribute the first of a proposed series of papers describing the additional work they have done on these stars since the first investigations in January 1898. The photographs have been obtained with the Yerkes 40-inch lens, which being corrected only for the visual rays, somewhat limited the region of spectrum available, until a correcting lens was obtained. This consists of a compound lens of 32 mm. aperture, supported in the cone of rays from the 40-inch objective at a distance of about 30 cm. from the slit of the spectroscope. The introduction of this lens decreases the focal length of the objective for light of λ 4500 by about 60 mm., but at the same time it so alters the original steepness of the colour-curve that it is found possible to photograph a much larger extent of spectrum at the same time.

The spectroscope originally used has been considerably modified. The collimator lens has an aperture of 31 mm. and focus of 507 mm. Three prisms of dense flint ($\mu = 1{\cdot}696$) are available, and for most of the work it has been found best to use a short camera, aperture of lens (a photographic doublet) being 37 mm. and its focal length 271 mm.

The width of the photographed spectra is usually about 0·18 mm.; the scale of the negatives is such that

at λ 4400, 1 mm. = 18·5 tenth metres;
,, λ 5350, 1 mm. = 49·6 tenth metres.

The authors proceed to describe in minute detail their methods of measurement and reduction, introducing a very ingenious *interpolating* machine they have devised to draw the reduction curves as accurately as possible.

Several illustrations accompany the article, showing the breech-piece of the 40-inch with various spectroscopes in position, two views of the interpolating machine, and a reproduction of the spectrum of 152 Schjellerup extending from λ 4800 to λ 6300. With respect to the latter, attention is drawn to the apparent bright line at λ 5592. The authors find it is easily photographed with *four minutes'* exposure, while to obtain the continuous spectrum adjoining of equal density takes from 12 to 15 minutes. This they think is in favour of its being a true bright line. From its appearance, they think it probable that whatever substance produces this line must exist in the star's atmosphere at a level *above* that of the carbon or hydrocarbon vapour which produces the heavy absorption-bands.

PHOTOMETRY OF THE PLEIADES.—Herren G. Müller and P. Kempf, of the Potsdam Observatory, have been investigating the brightness of the component stars of the Pleiades group, and the greater part of *Astr. Nach.* (Bd. 150, Nos. 3587–8) is devoted to their communication. They begin by giving tables showing the values obtained for the magnitudes of the principal stars by previous authorities, including Lindeman, Pickering, and Pritchard, and also an analysis of these values showing the varying discrepancies between the several measures of the same star. Then follows an account of their work of determining the magnitudes of 96 stars of the group, the instrument used being a Zöllner photometer in conjunction with telescopes of varying apertures. Full details are given of the preliminary experiments made for determining the constants of the instruments, &c., using certain of the stars as standards.

THE SYSTEM OF SIRIUS.—In the *Astr. Nach.* (Bd 150, No. 3588), Herr H. J. Zwiers, of Leiden, gives a revision of his previously calculated elements for the Sirius system (*Astr. Nach.*, No. 3336), which he has been enabled to make by employing the recent measures of Messrs. Aitken and Hussey,

made at Mount Hamilton during 1898 and 1899. The elements he gives are the following :—

System II.

T = 1894·0900	$i = 46° 1'·9$
$\mu = -7°·37069$	$\Omega = 44° 30'·2$ (1900)
P = 48·8421 years	$\pi - \Omega = 212° 6'·4$
$e = 0·5875$	

The mean value of the distance of the companion is given as

$$a = 7''·594.$$

CATALOGUE OF ASTRONOMICAL INSTRUMENTS.—Sir Howard Grubb has sent us a revised edition of his catalogue of astronomical instruments, observatories, &c., showing the nature of the work turned out from his workshops at Rathmines, Dublin. The quality and performance of these are well known to practical astronomers, the catalogue in its new form will be interesting to all from the beautiful illustrations with which it is furnished, showing in a most convincing manner the capabilities of various optical and mechanical contrivances. The frontispiece is a reproduction of a photograph of η Argus taken with the astrographic telescope at the Cape Observatory. At the end of the volume there are four plates showing "The solar eclipse of 1898," "A specimen of work done by a photographic doublet of 15 inches aperture," "The great nebula in Orion," and "The Dumb-bell nebula in Vulpecula"; the two latter being from negatives taken by Mr. W. E. Wilson with a reflector of 24 inches aperture.

THE CAPE OBSERVATORY.

THE annual report of Her Majesty's Astronomer at the Royal Observatory, Cape of Good Hope, for the year 1898, has recently been published. The following is a short *résumé* of the chief details :—

The McClean Telescope.—The equatorial mounting of this instrument, the generous gift of Mr. F. McClean, F.R.S., reached Table Bay in good order on April 11, 1898. In six weeks all the parts had been mounted and adjusted, the stand, however, requiring considerable modification. The fittings for electrical illumination of the circles, scales, and micrometers had to be made or remodelled at the Cape.

The hydraulic motor for rotating the dome arrived on July 4, the hydraulic ram and valves for automatic clock-winding on October 11, and by November 1 all the essentials of the observatory and stand were fitted and in good working order. The raising and lowering of the floor and rotation of the dome are commanded by cords which may be actuated by the observer at the eye-end of the telescope with the utmost ease and delicacy, while the hydraulic clock-winding gear, contrived by Mr. McClean, automatically winds up the clock-weight at short intervals without communicating the slightest vibration to the telescope.

The 18-inch visual object-glass has proved to be a very fine one, both its spherical and chromatic corrections being practically perfect, as far as the kinds of flint and crown glass at present procurable in discs of that size will allow.

The 24-inch glass has two faults : the marginal images show well-marked *coma*, and the minimum focus, instead of being near to or more refrangible than $H\gamma$, is for rays of refrangibility between $H\beta$ and $H\gamma$. It is understood that Sir Howard Grubb will remedy these defects. The slit spectroscope for line of sight work, made by the Cambridge Scientific Instrument Company, was shipped from London on December 21, and the 24-inch glass cannot be returned for alteration until tests have been made with this spectroscope in conjunction with it.

The New Transit Circle.—The foundations for the new transit circle have been built, and the observatory, of sheet steel, is constantly expected from Messrs. T. Cooke and Sons, of York. Messrs. Troughton and Simms reported that the transit circle itself would probably be ready in March 1899.

Astronomical Observations.—The work of the *transit circle* has been chiefly devoted to observations of standard stars for reduction of the measures of the "Catalogue Photographic Plates." During the year 10,355 meridian transits and 9863 determinations of zenith distance have been recorded.

With the *Heliometer* systematic observations of the major exterior planets have been made, the year's work including fifty-three measures of Jupiter, forty-four of Saturn, forty-five of Uranus, and seventy-two of Neptune, all during opposition. This instrument has also been employed in the triangulation of twenty-one stars surrounding the South Pole, and for investigation the possibility, first suggested by Dr. Rambaut, of atmospheric chromatic dispersion affecting the accuracy of heliometer observations. The *seven-inch equatorial* has been employed for observations of occultations, revision of star-lists, and Coddington's comet ; and the *six-inch telescope*, in conjunction with a Zöllner photometer, for the comparison of photographic and visual magnitudes in areas near the pole and equator of the Milky Way.

With the astrographic telescope, 469 plates have been obtained, 200 of these being "revision plates," as it is proposed to repeat the whole series of catalogue plates, in order to bring the epoch at which the plates were taken nearer to that at which the comparison stars were observed on the meridian.

Geodetic Survey of South Africa.—The field operations in connection with the geodetic survey of Rhodesia were resumed in May at the close of the rainy season, the early part of the year having been spent in training the observers in the use of the Jäderin base-measuring apparatus, the constants of which were accurately compared with the Cape measuring bars. The difference of longitude between Buluwayo and the Cape Observatory was determined by exchange of telegraphic signals on four nights, the astronomical latitude and azimuth being also observed. After the selection of a site, a base line of 11¾ miles in length was measured, and during the year seventeen stations were occupied and measurements taken therefrom.

An arrangement for the delimitation of the Anglo-German boundary between British Bechuanaland and German South-west Africa having been approved by both Governments on January 1, Lieutenant Wettstein and Major Laffan, R.E., after some months' sojourn at the observatory for practice in astronomical observations, commenced operations at Reitfontein (long. 20° E., lat. 26° 47′ S.) on November 19, by determinations of astronomical latitude and azimuth and the selection of stations.

The existing triangulation in the Cape Colony on the meridian of 20° E. long. is at present limited to the northern triangles of Sir Thomas Maclear's arc and to Bosman's accurate triangulation of Bechuanaland from Vryburg to the 20th meridian, and along that meridian from the Orange River to Reitfontein. There thus remains to complete the chain from Cape Agulhas (the southern point of Africa) to Reitfontein, a distance of only 140 miles to be filled in. The triangles for this work have been selected, and are about to be measured with the Repsold theodolite by Mr. Alston.

In connection with the survey of Rhodesia, Mr. Rhodes has promised that when he is in a position to commence the extension of the railway from Buluwayo to the Zambesi, he will place at the disposal of Her Majesty's Astronomer the funds necessary to carry on the arc of meridian from Southern Rhodesia to Lake Tanganyika. Thus there is in prospect the completion of the following valuable geodetic data :—

(1) A geodetic arc along the meridian of 20° E. long. from Cape Agulhas (lat. 34° 49′ S.) to the parallel of 22° S. lat., perhaps to 18° S. lat., *i.e.* an arc of 12° 49′, or possibly of 16° 49′ in length.

(2) An arc along the meridian of 30° E. long. from the south of Rhodesia (lat. 22° S.) to the southern extremity of Lake Tanganyika (lat. 8° 40′ S.), an arc of 13° 33′ in length. Both of these important operations will be under the direction of Her Majesty's Astronomer.

It is also hoped that the German Government will carry the latter work along the eastern border of Lake Tanganyika to Uganda, whence the way is now clear for a triangulation along the Nile to Alexandria, *i.e.* practically along the same meridian as above, 30° E. long. This latter work should for various reasons be commenced at its northern extremity.

Longitude of Lake Nyassa.—The longitude of Nkata Bay

on Lake Nyassa was determined by exchanges of signals between this station and the Observatory, made by Captain Close, R.E., and Dr. E. Kohlschutter. The adopted value for the longitude of the station occupied (which was 5·2s. west of the Bay) was

2h. 17m. 7·6s. E.,

and thus the previously accepted longitude was about six miles in error. This work was undertaken in connection with the delimitation of the Anglo-German boundary between Lakes Nyassa and Tanganyika.

Longitude of Umtali.—Similar operations undertaken by Captain Watherstone, R.E., in connection with the Anglo-Portuguese Barué Delimitation Commission, gave the longitude of Umtali as 2h. 10m. 41·2s. E.

Time Service.—The usual distribution of time signals for commercial and navigation purposes has been carried out.

PROF. F. OMORI ON EARTHQUAKE-MOTION.

THREE important memoirs have recently been published by Dr. F. Omori, Professor of Seismology at the Imperial University of Tokio.[1] In the first he describes a form of horizontal pendulum adapted for mechanical registration, a method which, like the Italian seismologists, he prefers on account of its cheapness and the more open diagrams which it provides. The pendulum consists of a thin brass cylinder, filled with lead, and weighing about 14 kg. This is attached to a horizontal tubular strut of iron, which ends in a sharp conical steel point, working in a conical steel socket fixed to the wall of an earthquake-proof house. A fine steel wire connects the heavy-bob with a triangular steel prism, whose knife-edge works in a steel V-groove mounted on a projection from the upper part of the wall. The vertical distance between the points of suspension and support is 2½ metres, the horizontal distance being, as usual, very small. The length of the strut from its pivot to the axis of the cylinder is one metre. The complete period of vibration is at present 28 seconds in one pendulum, and 17 seconds in the other. The record is made by a light pointer, connected at one end with the cylinder and turning about a vertical axis working in a stirrup rigidly connected with the ground. At the end of the long arm is hinged a light triangular writing index, the point of which rests on smoked smooth paper, which is wrapped round a light wooden drum, 942 mm. in circumference, and revolving once an hour. While the Italian seismologists endeavour, as a rule, to render their instruments sensitive by using a heavy steady mass, Prof. Omori attains the same end by reducing the friction between the parts of the machine; for instance, the pressure of the writing index on the smoked paper is only ⅛ mgm. Prof. Omori also describes a portable form of the pendulum, in which the dimensions and heavy mass are smaller, and the points of suspension and support are connected with a cast-iron stand. The paper is illustrated by some interesting typical diagrams given by the pendulums of pulsatory oscillations and earthquake disturbances of neighbouring and distant origin.

It is well known that most earthquakes begin with a preliminary tremor, consisting of vibrations whose amplitude is very small and whose period is generally very short. When the origin of the earthquake is distant, the duration of the tremors, as noticed by Prof. Milne and others, increases with the distance of the observing station; and a similar relation, as Prof Omori points out in his second paper, is evident from an examination of different seismograms obtained in Japan. He shows that the duration of the preliminary tremor does not depend on the magnitude of the disturbed area of the earthquake, for no difference of this kind is to be seen between the disastrous Mino-Owari earthquake of 1891 and its five strongest after-shocks. He finds, moreover, that, for great earthquakes originating at distances between 100 and 1000 km., the duration increases by 15 seconds for every increase of 100 km. in the distance from the origin. The duration of the tremor being ascertained at two or more stations, it is thus possible to determine the position of the epicentre; and, in two cases which are given the results agree closely with those obtained from isoseismal lines. Prof. Omori remarks that the approximate variation of the duration of the early tremors with the distance from the origin can be explained by assuming the existence of two sets of waves, which, starting simultaneously, are propagated with different velocities. The mean velocities for the Mino-Owari earthquake of 1891 and the Hokkaido earthquake of 1894 are 2·2 km. per sec. for the preliminary tremors and 1·7 km. per sec. for the principal waves.

The third paper, written in conjunction with Mr. K. Hirata, is a valuable discussion of the earthquake measurements made at Miyako from June 1896 to June 1898. The observatory, which contains a Gray-Milne seismograph, is situated on a small promontory of palæozoic rocks (in lat. 39° 38′ N. and long. 141° 59′ E.), and the records may therefore be regarded as good illustrations of earthquake measurements in a rocky district. Of the twenty-five earthquakes which form the principal subjects of the discussion, six originated in the mountainous regions to the west, and the remaining nineteen under the Pacific Ocean, the point one degree east of Miyako being the most active centre of the earthquakes which disturb the eastern part of Northern Japan. The authors arrive at the following important conclusions. As a general rule, the duration of an earthquake seems to vary directly as the magnitude of the disturbed area and inversely as the distance of the observing station from the origin. The average duration of the vertical component is about four-fifths that of the horizontal component. The period of the maximum movement, both horizontal and vertical, ranges between 0·53 and 1·7 seconds for slow undulations, and between 0·12 and 0·15 second for ripples. The average period of the horizontal slow undulations is approximately constant in the principal and end portions of an earthquake, while that of the ripples is slightly greater during the principal portion than during the preliminary tremors and end portion. It is remarkable that the average period of ripples is roughly constant in all the earthquakes here considered, never varying much from one-tenth of a second. The range of the vertical motion was invariably less than that of the corresponding horizontal motion, the maximum vertical motion being on an average one-fifth of the maximum horizontal motion; and this is true both for ripples and slow undulations. The direction of the maximum earthquake movement, as a rule, is coincident with the direction of the line joining the observing station to the centre. In two earthquakes (those of February 7 and April 30, 1897), the angle of emergence can be ascertained as well as the position of the epicentre, and from these data the focal depths are found to be 15 and 9 km. respectively.

[1] (1) "Horizontal pendulums for registering mechanically earthquakes and other earth movements": *Journ. Coll. Sci., Imp. Univ., Tokio*, vol. xi. 1899, pp. 121–145; (2) "Note on the preliminary tremor of earthquake-motion": *ibid.*, pp. 147–159; (3) "Earthquake measurement at Miyako": *ibid.*, pp. 161–195.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

MR. A. W. BRIGHTMORE has been appointed professor of engineering construction and surveying at the Royal Indian Engineering College, Cooper's Hill.

ALL particulars referring to the technological examinations conducted by the City and Guilds of London Institute, and the regulations for the registration and inspection of classes in technology and manual training, will be found in the official "Programme" just published by Messrs. Whittaker and Co. The syllabuses of the seventy different subjects, with the list of works of reference in each, and the examination papers set this year, should prove of service both to teachers and students of technology.

THE ninth summer meeting of University Extension Students in Oxford terminated on Wednesday, August 24. The meeting was throughout uniformly successful. It was divided, as usual, into two parts, the first part terminating on August 9. The number of visitors to the meeting amounted to about 1000. Of these considerably over 100 came from Germany and the United States, other nationalities being fairly well represented. The historical period selected for study was the nineteenth century from 1837, and the scientific section of the meeting was therefore necessarily occupied with the more important results obtained during that period. The lectures were well attended and excited considerable interest. In Part I., Prof. Gotch gave two lectures on "The physiology of sensation," Mr. G. C. Bourne two on "The growth of the living organism," and Prof. H. A.

Miers one on "The growth of a crystal." Mr. H. N. Dickson lectured on the "Influence of climate," and Prof. W. J. Sollas on the "Geology of Oxford." In Part II., considerably more attention was devoted to scientific subjects. Prof. W. J. Sollas conducted a series of geological classes and excursions, and Mr. A. W. Brown gave a course of practical instruction in illustration of Mr. G. C. Bourne's lectures in Part I. Dr. Farrar gave two lectures on "Prehistoric man." Two of the evening lectures were devoted to science, Dr. A. Ransome, F.R.S., discussing microbes and disease, and Mr. G. J. Burch "Wireless telegraphy." Both lectures were admirably illustrated.

THE following important announcement is inserted in the new Directory (1899) of the Department of Science and Art:—"The Lords of the Committee of Council on Education have under consideration the assessment of the efficiency of instruction in the elementary stage of science and art subjects by inspection only. It is proposed to discontinue examinations, as a test for the purposes of assessing the grant in that stage, after the year 1900. It is proposed that papers shall continue to be set in that stage for students who may desire to be examined and to possess a certificate of having passed the examination; but that in those cases a fee should be charged to cover the cost of examination." The Directory contains a number of new regulations affecting schools and classes connected with the Department of Science and Art. The object of most of the changes is evidently to encourage practical instruction in science. Visits of students to galleries, museums, and other public institutions, or attendance at field classes, may now be registered as attendances for grants. Theoretical mechanics and Section I. of the elementary stage of physiography have been added to the list of subjects in which grants for practical work may be given. The syllabuses of inorganic chemistry (theoretical) elementary stage and of theoretical and practical metallurgy have been revised, and slight modifications have been made in connection with the syllabuses of mathematics (Stage I.) and botany. With regard to schools of science, students under twelve years of age are to be excluded from them unless specially allowed by the inspector, and students at such schools are not as a rule to be admitted to the science and art examinations. Suggested laboratory arrangements for practical work in physics and biological subjects are described in the Directory, and should be of service in connection with the construction of small laboratories.

SCIENTIFIC SERIAL.

THE second part of the *Zeitschrift für Wissenschaftliche Zoologie* for 1899 contains two important contributions to the morphology of Invertebrates. The first, by Dr. P. Obst, discusses the fate of the nucleolus in the development of the ovum of certain Molluscs and Arachnids; while the second, by Dr. E. Zander, deals with the abdominal bristle-like apparatus of the Hymenoptera. Especial interest attaches to the latter communication from the author's discovery that the first formation of the abdominal appendages and of the accessory sexual organs (gonapophyses) belongs to two distinct periods of development. The first of these are truly embryological, making their appearance during ovular development, whereas the second do not commence till an early larval stage is attained.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 21.—M. Maurice Lévy in the chair.—The Perpetual Secretary announced to the Academy the loss it had sustained by the deaths of MM. Frankland and Bunsen, Foreign Associates of the Academy.—On the cause of the persistent luminous trains which accompany certain shooting stars, by M. Ch. André. Remarks on an observation by MM. Lagrula and Luizet of one of the Perseids seen on August 12; the luminous streak of the meteor could be seen for twenty minutes, during which time marked changes of form were obvious in the trail of the meteor. — On an infinite continuous group of transformation of contact between right lines and spheres, by M. E. O. Lovett.—A method for determining the Newtonian constant, by M. G. K. Burgess. The Cavendish method is modified by supporting the weight carried by the torsion thread in a bath of mercury. In this way it was possible to suspend a mass of lead of two kilograms each on a torsion wire of bronze or platinum of 0·05 mm. diameter. The sensibility of this apparatus is very great, a shifting of the large masses (10 kgr. each) through 40° turning the torsion system through about 12°. The chief difficulties would appear to be the necessity of keeping the temperature of the mercury absolutely constant, and the variations introduced by fluctuations in the surface-tension of the mercury.—On the magnetic properties of iron at low temperatures, by M. Georges Claude. The hysteresis and permeability of iron are both practically constant over the temperature-range, +25° C. to −185° C., the permeability at −185° C. being only 2·5 per cent. less than at 25° C. These results are in agreement with the experiments of Thiessen, carried out at temperatures of −80°, but are in opposition to the results of Dewar and Fleming.—Decomposition of phosphate of manganese by water at 0° and 100° C., by M. Georges Viard.—On the persistence of the cardiac contractions in the phenomena of regression in the Tunicates, by M. Antoine Pizon.—On temperature and its variations in free air, from observations in ninety captive balloons, by M. L. Teisserenc de Bort. The temperature at different heights presents in the course of the year variations much more considerable than had been supposed from the observations made in an ordinary balloon. Even as high as 10,000 metres there is a marked tendency to an annual variation of temperature.

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