Nature

A WEEKLY

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"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH

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NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

THURSDAY, NOVEMBER 2, 1899.

WATER, WATER, EVERYWHERE.

The Theory of Water Finding by the Divining Rod: its History, Method, Utility and Practice. By B. Tompkins, W.F., author of the "Theory of Water Finding." Second and enlarged edition, with illustrations. Pp. ix + 127. Copyright and all rights reserved. (Published by the author, B. Tompkins, Expert Water Finder, Chippenham, Wilts, 1899.)

BOTH the subject and the method of treatment of the Theory of Water Finding by the Divining Rod, by Mr. B. Tompkins, W.F., are so unlike what are usually met with by those gentlemen whom you, Mr. Editor, honour by a request for a review, and there are such risks of becoming involved in a sort of fourth-dimensional conflict or of giving offence, that I feel the case is one in which the reviewer should write in the first person, and sign his name. Neither the editorial we nor the security of anonymity would, in my opinion, be appropriate.

Mr. Tompkins is a thorough enthusiast; he has discovered that he possesses a power denied to most mortals, and this he practises, so we read in his book, to the great advantage of dwellers mostly in the West of England, in Wales and in South Africa. Evidence of this is given at once in a list, covering seven pages, of patrons, many with handles to one or other end of their names, and of public bodies for whom Mr. Tompkins has found Springs of Running Water.

The divining rod has been known from ancient times, and we are told has been practised for "the tracing of boundaries, murderers, mines, metals, minerals, and hidden sources of water" (mostly things beginning with an "M," as in Alice). "The scientific name given to the art is Rhabomancy."

"The rod is regarded as a symbol of authority, and is often referred to as such in Holy Scripture, and employed in schools. There are, I find, some 130 references to a 'rod,' staff or sceptre as a symbol of power or authority."

Three instances are given in which Moses used a rod with great effect, and Aaron's rod budded. We need not, therefore, be surprised at the success of the Diviner or present Professional Expert Water-Finder.

Mr. Tompkins goes at some length and detail into his own early history and experiences, for which he gives the following excellent reason:—

"My object in giving a detailed account of genealogy and career is to show that the suppositions made by so many persons, that the Water-Finder is some supernatural being, of a low class, possessing a supernatural power, inherited from a race which existed before the flood mentioned in the sixth chapter of Genesis, caused by the amalgamation of these people, resulting in their possessing occult arts, and from these sprung the Water-Finder, are incorrect and most absurd, absolutely without foundation, they being drowned by the Flood; and further there exists no evidence of a supernatural power, which my readers will see later on."

Here is the account of Mr. Tompkins' discovery of his power of water-finding.

"Quite alone and in the month of February 1886, one who was destined to become a philanthropist of some repute, and play an important part in the affairs of life, steps forth quite unconscious of these thoughts being in his mind, or that they were really in existence as regard to his future prospects. Like a nest within a nest . . . I lifted my eyes and saw the trees and hedges just showing signs of life; in one I saw a white thorn twig . . . I held this rod by both prongs in both hands, so—" (here is a picture) "gripping it tightly so that it should not move, and commenced to walk in an upright position, with the apex of the twig downward and some distance from the ground. This was in an orchard where there were no signs of water existing or wells near, or any indication that water could be found at one place more than another. After walking a distance of 80 yards or so, I suddenly felt a running or creeping sensation come into my feet, up my legs and back and down my arms which caused me to look to see what had happened. I noticed the rod began to rise in my hands; I gripped it still tighter to prevent it, and kept walking; still I found the sensation get stronger and stronger, and that I was being led in a zigzag course, the twig at the same time exercising a great determination to turn up. So strong had this influence become that I was powerless to keep it down, and eventually after proceeding some distance further it attained a vertical position, and revolved over and over. So great was this sudden and unexpected pressure or influence on me that I fainted and became very ill. . . ."

I may add for the benefit of those interested that Mr. Tompkins recovered, and is now able to undertake Water-Finding with no other ill results than considerable fatigue.

Of course, people whose reasoning powers have chiefly been developed in the school or the laboratory find a great difficulty in understanding how this power of water-finding can be explained, and Mr. Tompkins makes the following observation, with which few will disagree :—

"The refusal of its acceptance (the gift of water-finding) by some is because scientists have not yet been able to fully explain the marvels, or apparent marvels, in connection therewith, as, if an occurrence that has not been explained by scientific methods, must necessarily be a fraud."

However, this difficulty need not now trouble the public any more because Mr. Tompkins has given a very convincing explanation, which is much more obvious when pointed out than a great deal that is to be found even in these columns or in ordinary scientific books. This is Mr. Tompkins' explanation :—

"It is a well-known scientific fact that water is a generator of electricity, whether in passing through earth in its natural state or any artificial means employed, creates or produces this power through the various fissures or strata through which it passes. The Expert, medium, or Water-Finder, being, as I have previously stated, of a sensitive nature or organism, the moment he passes over or comes across these currents, becomes the receiving instrument for the time being, and there is no question but that the means used (viz. the Divining-Rod) becomes for the time being a part of the Diviner as an indicator in so far as are the hands of a clock, watch, weather-glass, steam-gauge, or the automatic weighing engine and scales seen so frequently in public places of resort."

Then follow two or three pages, too long to copy, and in which the argument would be lost if only extracts were given, but so novel as to be well worth reading, in which Mr. Tompkins proves conclusively, to himself, that electricity or a magnetic influence really does the work. One sentence is beautifully clear :

"The rod immediately points in the direction in which the current flows up to a certain spot, when the rod rises to its full height, and because it cannot go higher than a vertical position it revolves over and over again."

It is interesting to follow the scientific method of elimination made use of by Mr. Tompkins when he is finding other things than water. As already explained, the rod will find all manner of things, but a difficulty must be felt in discriminating. This is how it is done. If you are looking for gold and the rod rises, you then put gold in both hands, when the rod will at once fail to indicate anything if it rose for gold, but it will still rise if it rose for water or silver, or murderers, or boundaries, or things other than gold. The same is true for silver. We can only infer that the murderer can be discriminated by putting a murderer in each hand, but this is not stated. At any rate, Mr. Tompkins proves the gold story by explaining how he found a sovereign under the floor when the Bath and West of England Show visited Gloucester.

While on the scientific explanation of the action of the divining rod, it may be worth while to refer to an article by Mr. John Wallis Mulcaster, late Fellow of the Royal Astronomical Society, and late Member of the London Mathematical Society, quoted by Mr. Tompkins. This gives a good many more details in the proof of the electrical relationship of the divining rod than Mr. Tompkins employed in his more general type of reasoning. He begins :

"All minerals and water, more or less, emit an effluvia, composed of minute particles or physical atoms, of the substance they represent." . . . (Then follows an explanation of the reason why the depth can be judged). . . . "On arrival at the surface of the earth, those minute particles of metal, &c., having a tendency to ascend in vertical lines, the superincumbent air has also a tendency to press them down, whilst the particles are continuously driven forward by those that follow them. Now the divining rod being composed of a porous and fibrous substance, it follows through the natural order of things, that the physical atoms or minute particles of metal being driven up and down by opposing vertical forces, enter the interstices of the light porous wood, which gives them an easy passage."

This, of course, explains why the rod gets parallel to the ascending atoms so clearly that the non-scientific countryman would understand it as well as and perhaps even better than a trained physicist. Mr. Mulcaster goes on to show why it is only running water that will act on the twig, stagnant water being no good, but he has not explained why stagnant metals work. I do not feel equal to the task of supplying the omission with confidence, but on the whole it seems most likely that it has to do with "the natural order of things." Mr. Mulcaster is well aware in conclusion that in his lengthened remarks he has exploded certain ideas hitherto held on this subject for generations, and that the "electro-corpuscle" theory provides the explanation of the so-called mysterious action of the divining rod.

Perhaps enough has been written to give a fair idea of the style and scientific merit of Mr. Tompkins' book. The subject, however, should not be dismissed here. There is no question but that a large number of people of every class, except, perhaps, the purely logical, if there is such a class, are firmly persuaded that the Professional Expert Water-Finder with his Divining Rod can and does find water where ordinary folk, including geologists, fail; and what is more, that in quite a limited locality will, where sinking has failed to produce useful results, make their examination, find no water where failure has resulted, yet within a few yards assert that abundant water is to be found, which is verified on trial. Mr. Tompkins says the subject must be approached with an open mind, and he refers occasionally to X-rays and spiritualists. I hope in the following observations that I shall appear to have done so with a mind sufficiently open, but not gaping open so wide as to be practically turned inside out, a state which at any rate is conducive to sport when chasing spooks guarded by impostors.

Mr. Tompkins, who in many respects appears to be a very able exponent of the Diviner's Gift (not Art) explains how in walking over the ground he feels a sensation, a faculty possessed by only very few people, when he comes to the neighbourhood of running water, and that this sensation gets stronger as he approaches the "Head of the Spring," so that without any stick at all he could be guided to the best place for sinking for water. Further, that the sensation enables him to judge the depth as well as the quantity of water which is to be obtained. The twig serves as a kind of indicator; it is not absolutely essential, but he prefers to go to work in the recognised way; he believes "using a rod is the most successful and satisfactory to the public." So he cuts a forked stick of white thorn or hazel, as he finds these woods best. Ash is too sensitive, oak too sluggish, so the depth is over- or under-rated with these woods, while willow is too soft, so that it turns too easily and becomes useless. The depth of the water is estimated from the

"action or velocity of the rod and the amount of pressure upon the body . . . the yield by the strength and number of strata or streams which converge to the Spring Head. . . . The principle of its action is as a steam gauge on a boiler or engine, indicating the amount of pressure of the steam."

Mr. Tompkins apparently is convinced of the certainty of the method, for he says

"I should like to mention the fact that I have never had an engagement in which I have not found a spring if one existed."

Mr. Tompkins cites X-rays as an instance where a genuine physical agent exists where only a few years ago such action would have been considered impossible by scientific men; why, therefore, should there not be an emanation or "an effluvia" from the running water which might be detected by a sensitive person? I will make Mr. Tompkins a present of another analogy even more to the point. Gravitation, which on a large scale is of the most stupendous importance, so much so that even chemical energy sinks into insignificance by comparison, is yet so feeble when exerted between moderate quantities of matter that it could never have been discovered in the laboratory, and even now, with all our delicate instruments, is not provided against as a disturbing factor. By specially refined means, however, it can be detected and measured in the laboratory. Why should there not be an influence rising vertically from running water which we cannot detect in the laboratory, but which a few sensitive people might feel? We know that quite ordinary people can detect and be greatly affected by the difference in the air of two neighbouring places—one bracing, one relaxing—which cannot be directly traced to a chemical or physical cause. Again, it is maintained that there are people who are instantly aware if a cat is in the room, even though no one in the room may have seen or heard it, and who cannot remain unless the poor beast is removed. I am not referring to those who only find this out after they have seen the cat; that is merely an excess of affectation which should have been spanked out of them when they were young. The first sort, if they really exist, are certainly incredibly sensitive and are far more worthy of being considered supernatural beings than even Mr. Tompkins, if we may judge him by his book. It is hardly logical, therefore, to assert that a specially sensitive person cannot possibly be affected by the existence of water near or below him, but it is very difficult to see by what process the emanation is constrained to move vertically. Any one would have expected that if the "Spring Head" were, say, 50 feet down, there would be a greater effect upon the diviner at, say, 10 feet away from the vertical, but upon the ground, than exactly over it, and, say, 20 feet above the ground; but no, for Mr. Beaven, of Hereford, in a letter quoted, states that Mr. Tompkins in one case located a spring when on the top of a monument, while in another case he actually

"had to climb to the top of a haystack to locate the exact spot where a downward shaft would disclose the spring."

Again Mr. Tompkins on one occasion, much to the surprise of the owner, found indications of water crossing under a lawn where as a fact a water-pipe had been laid. Do the effluvia escape through the metal, or did Mr. Tompkins feel the presence of the metal itself? One of Mr. Tompkins' strongest arguments is that he adopts the professional custom of the water-finder, which is "No water, no pay," even though, to use his own words,

"to-day his name stands boldly before the British Public —in fact absolutely alone—as the only discoverer and guarantor of the 'Head of the Spring.'"

There seem really to be two questions: (1) Can the water-finder by his sensations, whether with or without a divining rod, indicate the position and yield of a hidden spring without employing any knowledge of geological conditions or experience as to the lie and appearance of the land? (2) if so, has the divining-rod anything to do with his success? Of course, if he succeeds in consequence of mere reasoning based upon geological knowledge or experience, while none the less useful to the public, he is, as far as divining is concerned, a fraud.

Reasoning beings would require very strong evidence to be absolutely satisfied that the first question can be answered in the affirmative. Yet a gentleman known to me personally, with mechanical and scientific ability and plenty of common sense, is persuaded from what he has seen that a water-finder (in this case not Mr. Tompkins) can locate hidden water, and that he does so by feeling a sensation. This water-finder asserts freely that the divining-rod has nothing to do with the business at all. This gentleman's son, formerly a student at the Royal School of Mines, now a professional engineer, in whose ability and honesty I have absolute faith, went round with the water-finder, and noticed that he, too, was cognisant of some sensation when the water-finder found indications of water. Mr. Tompkins quotes, and I suppose correctly quotes, a letter from the Chairman of the Quarter Sessions for Herefordshire to the *County Council Times*, in which he states that out of curiosity he went round with a water-diviner and found that he could use the rod successfully himself. While he has no occasion to do this professionally, he now uses it to discover leaks in the embankment of a large piece of water on his estate caused by rats or rabbits which he could not easily find otherwise. Scores of examples might be given.

As I have stated, it does not seem a logical position to take up to say that the gift as distinct from the art is impossible, even though we may require a better quality rather than quantity of evidence than is available to be satisfied as to its reality. But the gift, if it exists, is not sufficiently dramatic to impress the public. It is here, to my mind, that the rod comes in. The forked twig, held as it is, can be made to rise, fall or rotate by an almost imperceptible movement of the hands, possibly after a time unintentionally on the part of the water-diviner, and the public is impressed. For the same reason it may be well to find that water can only be met with in some inconvenient position, such as under a haystack or the cellar of the house, or the corner arch of a large granary. Ignorant and credulous people will have much more faith in you if you put them to a little inconvenience.

If the water-finders would leave it here, there could be no cause of complaint, provided, of course, that they succeed where geologically trained people fail. But when they put forward preposterous "scientific explanations" such as I have extracted, it makes it very difficult not to come to the almost inevitable conclusion that the water-finder has no case, and that the surcharging of his fees by auditors is necessary for the protection of public bodies. Perhaps among the 130 references in the Bible to the rod, staff or sceptre already referred to is this, "a whip for the horse, a bridle for the ass, and a rod for the fool's back."

C. V. BOYS.

HISTORY OF THE ART OF EXPERIMENTING.

Geschichte der Physikalischen Experimentierkunst. Von Dr. E. Gerland und Dr. F. Traumüller. Pp. 427. (Leipzig: Wilhelm Engelmann, 1899.)

THIS work, illustrated by more than four hundred woodcuts, gives a most interesting account of the apparatus used and of the investigations made by scientific inventors from the earliest times at which records exist down to the invention of Morse's printing telegraph in 1843.

One of the most interesting things that appears on the face of this history is the great mechanical ingenuity of many of the inventors of ancient times, as, for example, Hero of Alexandra, who invented a penny-in-the-slot machine, and the almost entire absence of any attempt to carry out what we would now call an experimental investigation. The experimental investigation of natural phenomena is extraordinarily modern, and the looking for mere rules of sequence in the phenomena rather than transcendental souls, spirits, effluvia, and such like efficient causes, is still more modern. This history covers a period of some four thousand years; but experimental science of the modern type is not more than three hundred years old. It is only amongst scientific men that the nature of experimental inquiry has been appreciated for as long as three hundred years. The well-educated man has not appreciated its nature for more than fifty years, and it is only within the last few years that in Britain the characteristic nature of experimental science has been at all generally understood. Even now a person is considered well educated who does not understand how to learn from experiment and observation to regulate his life. As a consequence, many so-called well-educated persons make awful fools of themselves.

In addition to the history of the subject, there are in connection with each period interesting *résumés* of its peculiarities, and of how it was an advance on its predecessors and yet did not attain to the position of subsequent workers. For example, attention is called to the way in which Gilbert, though in many ways imbued with the modern spirit of experimental inquiry, was still so dominated by the notion that magnets were possessed with some sort of soul or spirit that he cannot be rightly classed amongst the moderns, but is a sort of connecting link between them and mediæval superstitions.

There are two interesting questions that are not solved. One concerns the connection between Archimedes' observation in his bath, the method he employed to discover the amount of alloy in King Hero's crown, and the principle he enunciates in his writings as to the loss of weight of bodies immersed in a liquid. There seems no doubt from the description of the experiments he made (by observing the rise of water in a vessel when gold and silver were immersed in it) that he did not use weighings at all in his determination of the alloy in the crown. It would be interesting to know how he then discovered the amount of loss of weight of a body immersed in a liquid. What set him on observing this? The question is the more interesting in that most of the scientific workers of that age seem to have confined themselves to solving practical difficulties in the way of carrying out some project they had in hand, and were not at all imbued with the modern spirit of experimental research. The other question that needs elucidation is as to the observation of the Florentine Academicians that water could penetrate gold. This experiment used to be very commonly quoted to prove the ultimate porosity of solids, but it does not seem to have been repeated, and there are very grave doubts as to the genuineness of this penetration. It seems much more likely that the gold cracked, and that the Florentines did not observe this.

It has several times happened that all the necessary principles involved in subsequent inventions have been discovered, and attempts made to apply them long before the inventions were brought into actual use. In most cases it seems to have been the want of means or of push of the inventor that prevented him from getting his invention into use. There is a generally received notion that this want of success has been usually due to want of practical ability to get over difficulties that arise in actual use. This seems to have been true to only a very small degree. A very remarkable instance of an old invention coming into use is that of heat engines. Hero of Alexandria invented several forms of heat engine, including that latest development of steam engines a turbo-motor; yet it was only during last century that any serious use was made of them, unless imposing on the worshippers in Egyptian temples can be called a serious use. The rate of evolution of the steam engine has been most remarkable. Invented by Hero, it languished in an amœboid condition for many centuries, and then within two hundred years it developed into its present highly organised family of many genera and species. If a future geologist were to exhume the remains of steam engines, and were to have some means of determining the ages that elapsed between Hero's engines and that of Savery, and from these data were to evolve a chronology of the recent developments, he could hardly avoid concluding that it took at least a million years to develop the engines of a modern steamship from Savery's engine. Many other forms of engine have been proposed. Huygens' gunpowder engine is a natural parent of gas engines, and it seems possible that some smokeless explosive might be used for driving motor-cars; for though the fuel would be heavy the mechanism might be simple, and the opportunity for varying the work done at each stroke very considerable, so that its adaptability to the circumstances of motor-car propulsion would be great.

The work is so full of interesting matter that it would be hopeless, in a short review, to call attention to the tenth part of its contents. Accounts of Egyptian, Greek, Roman and Alexandrian inventions are followed by accounts of those of the Byzantines, Arabians and of the Middle Ages. Science progressed slowly in these dark ages. Ten pages suffice for the whole of the inventions of Europe for this thousand years. While the energies of mankind were divided between fasting and praying for others, and fighting and preying on others, there was but little time or opportunity for the study of nature. With the sixteenth century the tide of evolution of the means of studying nature had begun strongly to flow. At first rising slowly it has in this last century come like the bore on the Amazon, almost overwhelming us with the rapidity of its development.

G. F. F. G.

OUR BOOK SHELF.

The Diseases of Children. By G. Elder and J. S. Fowler. Pp. xii + 391. (London: C. Griffin and Co., Ltd., 1899.)

FEW things show more clearly the advance made in the practice of medicine within the last thirty years than the way in which the diseases of children are now regarded as compared with the place assigned to them a generation or so ago.

It was thought then that to attend to the common ailments of women and children, those of children especially, was work that scarcely demanded the preparation of a complete medical curriculum. Even a professor of medicine at one of the leading universities had the courage within living memory to say publicly that a two years' course would be quite enough for successful practice "among women and children."

Nowadays all this has changed. It is universally recognised that the physiology and the ailments of men are not a whit more intricate than those of women, and that both are simpler than those of children. To treat young children successfully requires, not only all the training and knowledge every good practitioner ought to posess, but important additions. Some of these additions, moreover, are natural gifts which cannot be acquired by any amount of training or patience. To be able to read a child's nature easily is as much a gift as a fine ear for music. Some men and women have it, and many more are completely without it. To succeed as specialists in children's ailments it is essential not to be without it.

The work before us is intended mainly for students, and one of its aims is to show them how and what to observe. A large part of the book is concerned with the physiology of growth, of nutrition and of the nervous system. Many of the illustrations are specially good.

The sections devoted to the study of diseases of the various systems, digestive, circulatory, &c., suffer from the condensation necessary in a work of this size. It is a hopeless business to try to make pemmican attractive. But, on the other hand, pemmican has its uses, and a book small enough to be carried to the bedside in a hospital ward will often help a student more, for a time, than larger and more interesting works could do. These he will read later and with a mind more ready to appreciate them.

Fowler and Elder's manual will not displace Ashby and Wright's on the same subject, but it is a sound and trustworthy guide in a difficult department of medical practice.

Analyses Électrolytiques. By Ad. Minet. Pp. 170 (Paris: Gauthier-Villars, Masson et Cie, 1899.)

THIS handy volume, which appears as one of the "Encyclopédie scientifique des Aide-Mémoire," affords another indication of the continually increasing application of electricity to chemical analysis. About a third of the book is devoted to the description of apparatus used in electro-chemical analysis and to general considerations of a practical and theoretical nature. The latter contain certain inaccuracies which indicate that the author is not conversant with the advances made during the last decade, in regard to our knowledge of the nature of salt solutions on the basis of the theory of electrolytic dissociation.

The second and third chapters deal respectively with the analysis of metalloids and with the quantitative determination of the metals when present in solutions free from other metals. The fourth chapter treats of the separation and determination of the metals in a mixture; while the last is devoted to a few technical applications, such as the analysis of industrial copper, of bronzes, and of brass.

The practical portion of the book is clearly written; but on account of the lack of details in the case of a considerable number of the analyses, the book can scarcely be recommended to electro-chemical students for use in the laboratory.

Essais des Huiles Essentielles. By Henri Labbé, Ingénieur-Chimiste. Pp. 187. (Paris: Masson et Cie.)

THIS neat little volume, which forms part of the "Encyclopédie scientifique des Aide-Mémoire," published under the direction of M. Leauté, is intended as an introduction to the analysis of essential oils, substances which, according to the author, are very liable to adulteration.

The directions given for analysis are too general and brief to be of real utility to the practical analyst, but the properties of the pure products, compiled from Schimmel and Co.'s publications and from other trustworthy sources, are carefully tabulated, so that the book will at least be serviceable for purposes of reference.

Chemistry for Organised Schools of Science. By S. Parrish, B.Sc., A.R.C.S. With Introduction by Dr. D. Forsyth. Pp. xiv + 262. (London: Macmillan and Co., Ltd., 1899.)

THE course of experimental work described in this volume is designed for students in Schools of Science of the Department of Science and Art during their first two years of study. It is the outcome of experience, and represents the work which pupils from thirteen to fifteen years of age can do and understand. Following the reformed plan of teaching chemistry, the course begins with simple chemical manipulations, weighing, solutions, distillation, the preparation of common gases, composition of water and air, formation of salts, carbon and its oxides and a few organic compounds. In the second year's course easy quantitative experiments are given, and attention is paid to the laws of chemical combination, symbols, formulæ, &c. The halogens, sulphur and its compounds, the estimation of volume, are among other subjects dealt with. The test-tubing exercises, which once formed the chief part of the work of the student of elementary chemistry, are omitted altogether; and in their place we have a rationally constructed course of work, in which the intimate relation between chemistry and physics is brought out. The pupil who is fortunate enough to receive instruction on these lines will be placed in the receptive intellectual attitude which should be the aim of all scientific education.

Natural and Artificial Methods of Ventilation. Pp. 66 + xvi. (London: Robert Boyle and Son, Ltd., 1899.)

THERE is a considerable difference of opinion among experts as to the most satisfactory system of ventilation. The system by which fresh, warm air is forced into rooms at the top while foul air escapes at the bottom has been introduced into a number of buildings; but the compilers of the present volume give extracts and diagrams from papers and reports to show that this method is wrong in principle, and inefficient in practice. It is held that the heating of a building should always be separate and distinct from that of the air supply, and that the only satisfactory means of ventilation is obtained by extracting the vitiated air near the ceilings of rooms, and admitting the fresh air at lower levels. This "natural" system has been successfully introduced by Messrs. Boyle into several public buildings.

Man, the Microcosm. Part I. The Nature of Man. By Leonard Hall, M.A. Pp. 82. (London: Williams and Norgate, 1899.)

DEFINING a monad as any living organism which consists of only one cell, the author's thesis is that man is a community of monads, each of which is a conscious being, and that "human consciousness must consist of the combined and co-ordinated consciousness of the individual monads." The theory is used to explain many facts concerning the nature of man as an individual and as a member of a social community.

The Reliquary and Illustrated Archaeologist. Edited by J. Romilly Allen. New Series. Vol. v. Pp. 288. (London: Bemrose and Sons, Ltd., 1899.)

MANY articles and notes of interest to all students of archæology are contained in this new volume, comprising the four quarterly numbers issued during the present year. The numerous illustrations of places and objects of archæological significance add to the attractiveness of a volume which appeals to every one interested in antiquities.

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.*]

Botany and the Indian Forest Department.

IN the issue of NATURE of this date I find the second part of Sir G. King's presidential address of Section K, Botany, delivered at the Dover meeting of the British Association. At the end of that address Sir G. King has made a strong attack on the Indian Forest Department, and on the teaching of botany at Coopers Hill College. He maintains that the forest officers trained in this country go out to India with an insufficient knowledge of systematic botany, and that they, on arrival in India, are not encouraged to familiarise themselves with the contents of the forests under their charge.

These assertions are in some respects not in accordance with the facts of the case, and in others they show that Sir G. King, in spite of his long Indian experience, has failed to grasp the real issues. I trust you will permit me to substantiate these two points.

To begin with, Sir G. King puts the cart before the horse. If, as he maintains, the ordinary forest officer educated in England now arrives in India without sufficient knowledge to enable him to recognise from their botanical characters the most well-marked Indian trees, it is chiefly due to the fact that it is nowadays almost impossible to secure a botanical teacher in this country who can impart the necessary knowledge to the students. Sir G. King feels this himself, hence his lamentations, at the end of his address, over the decay of the study of systematic botany in Britain. I feel sure that Sir W. Thiselton-Dyer will bear me out when I state that no botanical teacher has been appointed to Coopers Hill College except with his, and latterly also with Dr. D. H. Scott's, advice. They have been good enough to recommend to us the gentlemen whom they considered most suitable for our requirements, but, alas! not one of them, though all were excellent and even famous botanists in other respects, was a systematic botanist in the sense demanded by Sir G. King. Hence I must turn round upon him and say: "Provide well-equipped systematic botanists, and we shall be only too glad to have one of them." In other words, the main difficulty lies with the botanists of the present age, and not with the Forest Department.

On the other hand, we are not free from blame. Until the year 1890 botany was a compulsory subject in our entrance examination, but in that year it was, against my advice, made an optional subject. This, I believe, was due to the influence of the headmasters of our great public schools, who desired to pass their pupils straight into the service, without being obliged to teach special subjects, such as botany. I do not desire to discuss the general question here involved, but I do wish to state that the action in the direction just indicated was decidedly injurious to our special requirements. I am happy to say that during the last year botany has once more been placed amongst those subjects which every candidate for entrance into the forest branch of Coopers Hill College will have to take up.

As for myself, I may state that, ever since I started the forest branch of this College in 1885, I have constantly urged our botanical teachers to extend the study of systematic botany at the expense of other branches, such as physiology. But what with young men trained on the ordinary lines of our public schools, and with teachers with a decided leaning to branches of botany other than systematic, it has been a hard struggle. The otherwise excellent teachers of botany, whom we have had so far, did their best to take up systematic botany on the lines required by us; but that is a branch not learned in a day, and the first two of our botanists left us, for better appointments than we could offer, when they had fallen in with our requirement.

And yet I think Sir G. King goes too far when he states that the ordinary forest officer educated in England is unable to recognise from their botanical characters the most well-marked Indian trees. Cases like this do, no doubt, occur; but I am sure that Sir G. King's assertion does not hold good in the case of many of the men who have been sent to India. Indeed, several of them have developed a decided leaning towards systematic botany. At the same time, the task is, in a great part of India, far more difficult than would appear from Sir G. King's words. I should like to know what he understands by "the most well-marked Indian trees." There are some 4000 different species of trees and woody shrubs in Burma, and about half that number in Bengal-Assam. If Sir G. King expects our forest officers on arrival in the country to recognise even a moderate fraction of these species, then he aims at impossibilities, and his enthusiasm for systematic botany has carried him far beyond reasonable limits. To do what he requires demands a thoroughly trained botanical specialist; and even such a one would require many years to become acquainted with the trees, shrubs and herbs (as demanded by Sir G. King) of an Indian jungle in Burma, Bengal and many other parts of India. For such things the ordinary Indian forest officer has no time.

The statement made by Sir G. King, that the young forest officer on arrival in India is not encouraged to familiarise himself with the contents of the forests under his charge, is not in accordance with the facts of the case. On the contrary, it is made the first duty of the young officer, apart from the study of the language of the people. Sir G. King himself enumerates fourteen forest officers who, during the last thirty years, have done good botanical work. Of these, five have made important contributions to the systematic botany of India. Of the other nine, one was trained at Coopers Hill. Considering that all the men sent out from Coopers Hill are as yet young, and that to my certain knowledge several of them are likely to become botanists, I think Sir G. King's strictures are not justified. Unfortunately, he looks at the matter entirely from the enthusiastic botanist's point of view.

The Government of India does not wish every Indian forest officer to be a botanist. It is desirable that every now and then one of them should take up the subject as a speciality, but it would be disastrous if all took that line. I have no hesitation in saying that as soon as a forest officer takes up botany as a speciality he is, rare cases excepted, likely to become an indifferent forest officer. The ordinary officer of that class has no time for special botanical study.

Forestry is perhaps not a science in itself, but an industry based upon various branches of science, amongst which botany, geology and entomology are the most important. The forest officer cannot be an expert in each of these. To demand such a thing would be just as unreasonable as to demand that a medical man should be an expert in chemistry. The one is as impossible as the other; to become either takes practically a life-time. With the enormous growth of the several branches of science a very minute specialisation has become an absolute necessity, since only a very small fraction of men can be classed as geniuses, while the rest must be rated at the average capacity of the human race. The student of one branch must depend on the work of students in other branches. Thus the forester, instead of being the assistant of the botanist (as Sir G. King seems inclined to demand), must rely on the professional botanist for all the finer and more intricate problems of botany. All he requires is to acquire a sufficient knowledge of botany, so that he may utilise what the professional botanist tells him. For more he has no time, because he has to attend to quite another class of business. The Indian forest officer is an estate manager on a large scale; he must manage his estates in such a manner that they yield the largest possible amount of useful produce with the least possible outlay. For that end his time is taken up by sylvicultural and administrative duties, leaving but little of it for the special study of any of the branches of science upon which systematic forest management is based.

No doubt many of the pioneers of Indian forestry were botanists, but by no means all. Take, for instance, the protection of the forests against fire, a matter to which Sir G. King gives prominence. He himself states that Lieutenant (now General) Michael was the first who was successful in this direction in Madras. I may add that, as far as Central and Northern India are concerned, Colonel Pearson was the first to introduce successful fire conservancy. And yet neither of these two gentlemen will, I feel sure, claim to be a great botanist.

Sir D. Brandis, to whom, as Sir G. King points out, we owe, for the most part, the organisation of the Indian Forest Department, no doubt was a botanist; but he brought about that organisation, not as a botanist, but as an able forester and administrator of extraordinary energy.

Botany is a branch of science the study of which is most fascinating; but the faculties which produce a great botanist do not necessarily include those which are required to produce a great administrator; and herein lies the difficulty, in so far as the Indian Forest Department is concerned. I could point out more than one botanist who occupied the post of the head of the Forest Department in a province, and who could not possibly be counted amongst the successful forest administrators of India. In nearly all these cases so much time was given to botany that little—or, at any rate, not enough—time remained for the proper administration of the extensive Government forest estates which supply the people of the country with the necessary forest produce, and over and above yield now an annual net revenue of a million pounds. These results would be most seriously imperilled if our Indian forest officers were to take the line which Sir G. King recommends to them. W. SCHLICH.

Coopers Hill, October 19.

Dark Lightning Flashes.

As an amateur photographer of cloud-scenes, I have taken the image of the setting sun surrounded by clouds on many occasions. I never remember developing a plate in which the image was reversed after an ordinary rapid exposure. Lightning flashes, one would think, ought to be still more rarely reversed, if the chemical reactions of the salts in the gelatine film are solely responsible for the phenomenon; yet dark lightning flashes are not infrequently visible in the developed plates of a thunderstorm.

Dr. Lockyer's interesting photographs (vol. lx., p. 570) of dark flashes with bright cores suggest to my mind another interpretation. A lightning flash (and, for the matter of that, an electric spark) is doubtless a complex phenomenon. A disruptive discharge of high tensional electricity through the atmosphere represents, I take it, a core of rarefied (because incandescent) gases surrounded by an envelope of compressed air. Mr. C. V. Boys has shown (NATURE, vol. xlvii. p. 420) that "a wave or shell of compressed air gives rise to an image on the plate in which there is a dark line and a light line within it. Similarly, a wave of rarefaction must produce a light line with a dark line within it." Surely we have then in the lightning flash itself, when rightly illumined, the necessary data for the production of an image—a bright line edged with two dark lines, as represented in Dr. Lockyer's photographs. In such cases the advantages of a diffused illumination of the background of the scape are obvious. Possibly Mr. S. Bidwell's interpretation of the double flash is the correct one.

Hove, October 21. W. AINSLIE HOLLIS.

IT seems to me difficult to compare the photographic brightness of the disc of the setting sun with a brilliant flash of lightning. For my part I consider that lightning flashes give us every chance of obtaining photographic reversals, for they can be photographed at very close distances, amounting to a few hundred yards, while the rays from the sun's disc when near the horizon must pass through a long range of dense atmosphere which cuts off the most actinic and therefore photographic rays.

With regard to the second portion of Mr. Hollis' letter, the illustration in my article (NATURE, vol. lx. p. 573, Fig. 6) disproves rather than proves his suggestion in my estimation. If, as he assumes, the core may be considered the actual spark, and the outer portion the image of the wave or shell of compressed air, then, as the latter is not so luminous as the core, it ought to be best visible by reason of contrast against a bright background. A glance at Fig. 6 shows that this is not the case, for at C the core exists practically alone with an illuminated background, while without the background at A and B it is most developed.

I cannot convince myself that the large dark flash is a double one. A close examination of the negative strengthens the view that it is single, and the general appearance of the ramifications endorses it. WILLIAM J. S. LOCKYER.

Solar Physics Observatory, South Kensington, October 24.

A Gutta-percha Plant.

IN your issue of October 19 you report a communication made to the French Academy of Sciences by Messrs. Dybowski and C. Fron regarding the cultivation of *Eucommia ulmoïdes*, a plant said by them to contain gutta-percha. I am naturally much interested in the possibility of this interesting tree, the "Tu chung" of the Chinese, becoming of economic importance, as some years ago I investigated the bark and leaves of this plant with regard to the peculiar cells containing a rubber-like substance (*Trans. Linnean Society*, 1892, vol. iii., part 7).

Gutta-percha and caoutchouc behave very similarly towards many solvents; but the fact that the contents of these cells were dissolved or partially dissolved by turpentine at ordinary temperatures, whereas gutta-percha is only soluble in hot turpentine, led me to the conclusion that the contents of these cells were caoutchouc. This substance is much more frequently met with in the laticiferous cells than gutta-percha, which is almost restricted to the natural order Sapotaceæ. Eucommia will therefore, I think, be found to be a rubber, and not a gutta-percha yielding plant.

But in either case it is obvious that, with the opening up of China, this plant may become of great economic importance if, as seems probable from the investigations of Dybowski and Fron, it is easily cultivated and propagated.

F. E. WEISS.

The Owens College, Manchester, October 23.

Halo Round a Shadow.

ON a winter morning some years ago I was driving in a dog-cart from the Lizard across the Goonhilly Downs whilst a dense mist or cloud was matted down on the ground.

Our heads were in bright sunshine, which formed a coloured halo round the shadow of each of our heads on the mist as we travelled on. Half an hour later the mist was more diffused, and we saw a white mist bow in the sky. HOWARD FOX.

Falmouth, October 28.

ON THE DISTRIBUTION OF THE VARIOUS CHEMICAL GROUPS OF STARS.[1]

II.

THE results so far referred to have regard to the stars with dark lines in their spectra, but besides these there are many so-called bright-line stars.

I should state that there has necessarily been a change of front in our views with regard to these bright-line stars since they were first classified with nebulæ by Pickering and myself.

The nebulæ are separated from stars by the fact that in their case we have to deal with bright lines, that is to say, we are dealing with radiation phenomena, and not with absorption phenomena, as in the case of the stars so far considered; and in the first instance it was imagined that the bright-line stars were, from the chemical point of view, practically nebulæ, although they appeared as stars, because the brightest condensations of them were so limited or so far away that they gave a star-like appearance in the telescope.

Since that first grouping of bright-line stars, by the work chiefly of the American astronomers it has been found that in a large number of cases *they have also dark lines in their spectra*, and that being so we must classify them by their dark lines instead of by their bright ones; and the bright-line stars thus considered chiefly turn out to be gaseous stars, *with a difference*. What is that difference? It is this, I think: in the case of the bright-line stars we are dealing with the condensations of the most disturbed nebulæ in the heavens; together with the light which we get from the nucleus of that nebula which appears as a star and can be spectroscopically classified with the other dark-line stars, inasmuch as the surrounding vapours close to the star produce absorption, and therefore give us dark lines; other parts of the nebulæ, probably those further afield, give us bright lines which mix with the dark ones. Therefore we get both bright lines and dark lines under these conditions. So far as the result goes up to the present moment, it looks as we have now to consider that these bright-line stars, instead of being nebulæ merely, are gaseous stars at a very high temperature, in consequence of the fact that the nebula which is surrounding them, which is falling upon them, is increasing the temperature of the central mass by the change of *vis viva* into heat. Pickering,[2] in his discussion of these stars, had thirty-three to deal with, and he found that there was a wonderful tendency among these to group themselves along the Milky Way; that very few of them, in fact, lay outside its central plane; that is to say, the galactic latitude, as it is called, the distance in degrees from the plane was limited in the generality to only two degrees, and the greatest departure, the greatest galactic latitude, was something within nine degrees. That was the story in 1891. Two years afterwards Campbell, another distinguished American astronomer, also interested himself in this question of the bright-line stars, and he discussed them, his catalogue containing fifty-five as opposed to Pickering's thirty-three. He found also that they were collected almost exclusively in the Milky Way, and that outside the Milky Way practically none had ever been observed. The importance of this result I will indicate by and by, but in the meantime I can throw on the screen a very useful map which Campbell prepared. The central line of that map represents the galactic zone, the plane of the Milky Way, and he marks along it the different galactic longitudes, showing above and below the plane just a few degrees of galactic latitude north and south, sufficient to enable him to plot upon it all the bright-line stars which he discussed. The diagram shows that all these bright-line stars really are close to the central plane of the Milky Way. Only one out of the fifty-five is more than nine degrees from it, and this lies in a projecting spur, so that we cannot really say that that is out of the Milky Way. It is remarkable that these bright-line stars are not equally distributed along the Milky Way. They are chiefly condensed in two opposite regions, and there is one region in which they are markedly absent. The glass globe will show how the matter stands, I think, rather conveniently. We have the Milky Way represented by red tape. The secondary Milky Way, which starts from it at one point of the heavens and meets it again, is also indicated. Dark wafers mark the galactic longitudes and latitudes of the bright-line stars. We find that these stars begin just before the doubling commences. They go on, and are sometimes very numerous, and they end just after the doubling ends; and we notice there is a long range of the Milky Way where it is single in which there is absolutely no bright-line star at all. It looks, therefore, very much as if there is a something connected with this doubling of the Milky Way which produces the conditions which generate these bright-line stars.

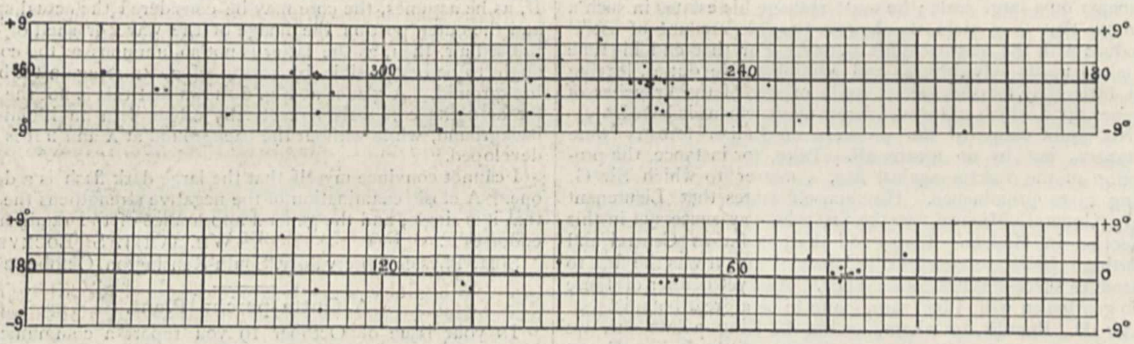

FIG. 3.—Distribution of the Wolf-Rayet stars in the Milky Way.

By the labours of Dunér, Pickering, McClean and Campbell, we are beginning to get very definite notions as to the distribution of the various chemically different stars in relation to the Milky Way. How about the nebulæ from the point of view of chemical distribution? Here we are in difficulties.

I have already stated that with regard to the general question of the nebulæ it is impossible to speak with certainty, because at present there has not been sufficient time and there has not been a sufficient number of observers at work to classify the thousands of "nebulæ" which we now know of into those which give us the gaseous spectrum, and those which are entirely different, apparently, in their constitution, and only give us what is called a continuous spectrum; but still we can go a

[1] A Lecture to Working Men, delivered at the Museum of Practical Geology, on April 10, by Prof. Sir Norman Lockyer, K.C.B., F.R.S. (Continued from vol. lx., p. 620.)

[2] *Astr. Nach.*, No. 2025.

little way in this direction by means of some figures which I have noted. The point is to see whether there is any difference in the distribution of those nebulæ, which are undoubtedly masses of gas, and give us the so-called nebulous spectrum, and those other nebulæ about which at present we know very little, but give us so-called continuous spectra. It is clear that on this point, undoubtedly at some future time, even if we cannot do it now, a great deal will be learned. The table I give brings the results up to the year 1894. If we take the region near the Milky Way, the region bounded by 10° galactic latitude north and south, and consider the planetary nebulæ distinguished by bright-line spectra, we find that there are forty-two; but if we deal with those which are further than 10° from the Milky Way, that number drops to five. If we take other nebulæ, not necessarily planetary, but gaseous like planetary nebulæ, inasmuch as they give us a spectrum of bright lines, we find that there are twenty-two in or near the Milky Way, and only six outside. If we take the so-called nebulæ known to have continuous spectra, which need not be nebulæ at all—we only imagine them to be nebulæ because they are so far away that we cannot get a really true account of them—we find that the conditions are absolutely reversed. There are only fourteen of them in the plane of the Milky Way, but there are forty-three lying outside it; so that the percentage within 10° of the Milky Way comes out to be eighty-four in the case of the planetary and the other nebulæ which give us bright lines, and in nebulæ with continuous spectra only 25. Therefore we get an absolute identity of result with regard to the bright-line stars and the other objects which give us bright-line spectra.

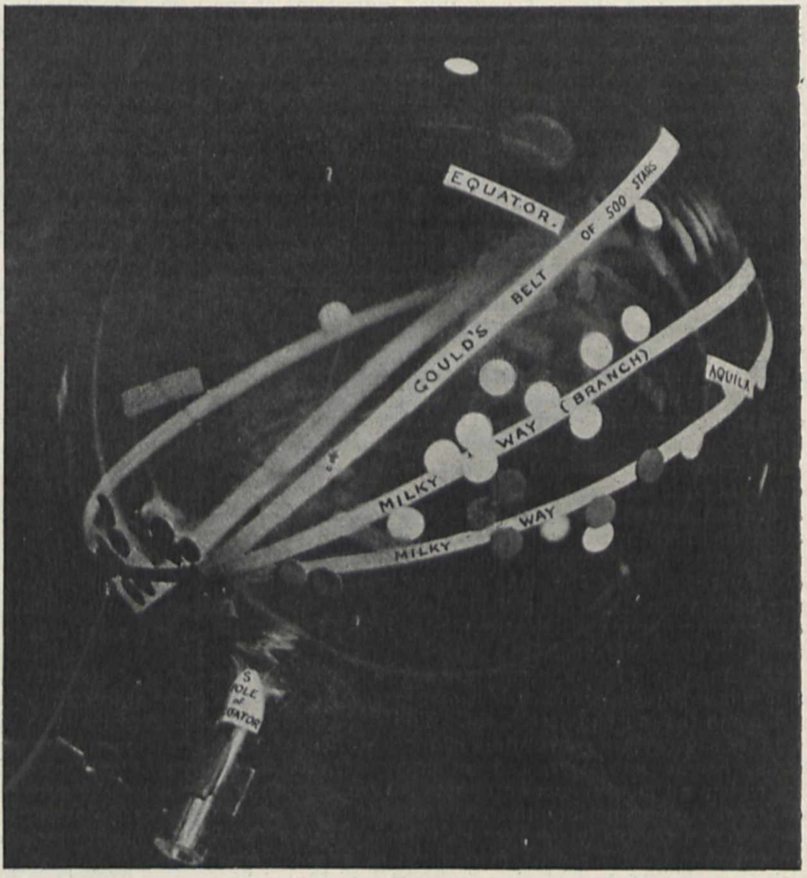

FIG. 4.—The Milky Way, where double in relation to the Equator and Gould's belt of stars, showing that the bright-line stars (dark wafers) and new stars (white wafers) are limited to the Milky Way.

There is another class of bodies of extreme interest. In fact, to some they are more interesting than all the other stars in the heavens put together (because they are "new stars"); each new star being supposed to be a new creation, so that for this reason everybody is very much agog to find out what they are like. When we come to examine these so-called new stars we find that they also are almost absolutely limited to the Milky Way, as shown in the table which gives the number of new stars, so-called, which have been observed in historic times. It begins at 134 years before Christ, and it ends last year. The number of stars thus reported as new stars is thirty-one, and of these only three have been seen outside the Milky Way. The glass globe will show in a convenient way what the facts are with regard to the new stars. The bright line stars being distinguished by dark wafers, the new stars are shown by white wafers. We notice that where we get practically the greatest number of dark wafers we get a considerable number of white ones. That means that these new stars take their origin in the same part of space as that occupied by the bright-line stars, and it is also interesting to point out that the void which I indicated where the Milky Way is single, where there were no bright-line stars, is equally true for the new stars; only one new star has been recorded in this region.

As I have said, a great deal of interest has been attached by many people to the question of the new stars, for the reason that whenever a new star appeared in a part of the heavens where no star was seen before, it was imagined that something miraculous and wonderful had happened. That was justifiable while we were ignorant, but recent work has shown, I think almost to a certainty, that the real genesis of a new star is simply this. We have near the Milky Way a great number of nebulæ, planetary or otherwise; we have more planetary nebulæ near the Milky Way than in any other part of the heavens; the nebulous patches also observed in it may include streams of meteorites rushing about under the influence of gravity; the origin of a new star is due to the circumstance that one of these unchronicled nebulæ suddenly finds itself invaded by one of these streams of meteorites. There is a clash. These meteorites we know enter our own atmosphere at the rate of thirty-three miles a second, and we may therefore be justified in assuming that any meteoritic stream in space, even in the Milky Way, would not be going very much more slowly. If we get this rapidly-moving stream passing through a nebula, which is supposed to be a mass of meteorites more or less at rest, of course we must get collisions; of course, also, we shall get heat, and therefore light. When the stream has passed through the nebula the luminosity will dim and ultimately, attention having been called by this cataclysm to that particular part of space, we shall find that there is a nebula there. This has always been so; and therefore in the case of new stars we must always expect to get indications of the existence of two bodies, the intruder and the body intruded upon.

We must also expect, if we are dealing with small particles of meteoritic dust, that the action will be very quick, and that the war will be soon over. All this really agrees with the facts. I will, just in order to point my remarks, show what happened in the case of the new star we were fortunate enough to have the opportunity of observing in the northern hemisphere not very long ago, the new star in the constellation Auriga. We have in the diagram the stars in the region in question; a black arrow indicates a dark space in the heavens where there is no star. The next drawing shows the same stars and the same region of the heavens; but we observe that in the centre is a star, which is the new star. In the spectrum of it we obtained undoubted indications of the fact that we were dealing with two different masses of matter; for the reason that if you take the chief spectral lines marked G, *h*, H and K, that is to say, the lines of hydrogen and of calcium, we find both bright lines and dark lines, which being interpreted means that hydrogen and calcium were both giving out light and stopping light. We cannot imagine that the *same* particles of calcium and of hydrogen were both giving out light and stopping light; there must have been different particles of hydrogen and calcium giving light and different particles of hydrogen and calcium stopping light; and if we look at the photograph carefully we find that the bright lines and the dark lines are side by side, and we know that that means a change of wave-length in consequence of movement, and we also know from the change of wave-length indicated that the differential velocity of the particles which gave us the bright hydrogen and calcium, and the dark hydrogen and calcium, must have been something like 500 miles a second. In that way we obtained indisputable proof that we were really dealing with two perfectly different series of particles moving in opposite directions, and that that was the reason we got that sudden illumination in the heavens which as suddenly died out until finally a nebula previously undiscovered was found to occupy the place. The nebula is really not the result, the nebula was the cause, but we did not know of its existence until our special attention had been drawn to that part of the heavens.

So much then for the first statement of facts relating to the distribution of the various star groups and nebular groups in the most general form. The next question is, Can we say anything about the distances of these gaseous stars, bright line stars, and other types? The way in which an astronomer attempts to determine the different distances which the stars occupy in relation to the earth may really be very well grasped, I think, by considering what happens to one when travelling in a railway train. If the train is going fairly quickly, and we look at the near objects, we find that they appear to rush by so rapidly that they tire the eye, and one naturally looks at the objects which are more distant; the more distant the object we look at is the more slowly it appears to move, and the less the eye is fatigued. Now, suppose that instead of the train rushing through the country and passing the objects which we regard under these different conditions, the different objects are rushing past us at rest. Then, obviously, those things which appear to be moving most quickly will be those nearest, and the more distant objects, just because they are distant, will appear to move more slowly; that is to say, we shall get what is called a large "proper motion"—in the case of the objects nearest to us—and a small "proper motion" —in the case of the bodies which are further away.

This question has been attacked with regard to the stars in magnificent fashion by a great number of astronomers. A photograph will show in a diagrammatic form the very various rates of proper motion which have been assigned by careful observation to a very great number of the stars. In the chart the amount of proper motion of the various stars is indicated by the lengths of the lines which proceed from them, and the direction in which the various stars appear to be moving is also indicated by the direction which these lines take. Some of the lines are extremely long; they seem to stretch over a large part of the sky. Of course the scale is an exaggerated one, but it is the *relative* motion that we have chiefly to deal with, and we find that on the same scale in some cases the lines are extremely short; so that the diagram tells us that the amount of proper motion is apt to vary very considerably. We have large proper motions and small proper motions among the stars.

It was Mr. Monck who was the first to show in 1892[1] that the gaseous stars had the smallest proper motion; that is to say, that the hottest stars were further away from us than the cooler ones. That is a good, definite statement, and one which everybody can understand. He next found that the proto-metallic stars—that is to say, the stars not so hot as the gaseous ones, but hotter than the metallic ones—had the next smaller proper motion. This, of course, indicates that the metallic stars are the nearest to us unless proper motion does not depend upon distance, but rather upon a greater average velocity in space. It has been shown, however, by considering the sun's movement in space, that this view probably may be neglected. The first discussion of proper motion then went to show, roughly, that the hotter a star is the further away from us it is; and it made out a fair case for the conclusion that the sun forms one of a group or cluster of stars in which the predominating type of spectrum is similar to its own.

Kapteyn carried the inquiry a stage further.[2] Working upon the idea that stars with the greatest proper motion are on the average the nearest, the part of the proper motion due to the sun's translation in space he considered must depend strictly upon the distance, and he determined this by resolving the observed proper motion along a great circle passing through the point of space towards which the sun is moving, which is called the apex of the sun's way, and reducing to a point 90° from the apex. His results were practically the same as those obtained by taking the individual proper motions. He also found that stars with the greatest proper motion are mainly metallic, and have no regard at all to the Milky Way; that stars with the smallest and no observable proper motion are gaseous and proto-metallic, including a few metallic ones which have collected in the galactic plane. In this he agrees with the prior observations to which I have drawn attention. In the table which I now give the mean proper motion is shown.

Relation between Spectra and Proper Motions of Stars (Kapteyn).

Mean proper motion.	Gaseous and proto-metallic stars.	Metallic stars.	Metallic flutings.	Ratio, metallic to gaseous.
″ 1·39	3	51	—	17·0
0·52	12	66	1	5·5
0·35	14	66	—	4·7
0·24	34	124	—	3·6
0·18	35	67	3	1·9
Inappreciable	79	35	1	0·44

The table deals with something over a second, which may be looked upon as a great proper motion, down to the tenth of a second, which may be regarded as a small one;

1 "Astronomy and Astro-Physics," xviii., 2, p. 876.
2 Amsterdam Academy of Science, 1893.

and we find that the gaseous and proto-metallic stars increase in number as the proper motion decreases. We find also the ratio of the metallic to the gaseous and the proto-metallic. We begin with a ratio of 17, and end with something like a ratio of half, so that the results may be considered to be pretty definite. These results were obtained by Kapteyn with 591 stars which were common to Stumpe's catalogue of proper motions and the Draper catalogue dealing with spectra. The general result may, therefore, be stated that at the nearest distance the metallic stars are seventeen times more numerous than gaseous stars, and at the greatest distance they are not half the number. Here again the question arises, how far the intrinsic brightness of these bodies, in relation to their distance from us and the possible greater or less extinction of light in space, has to be taken into consideration. That is a problem which will require a considerable amount of work in the future. It is rather remarkable that if we take the stars with very great proper motion, very much greater than the average, we find with regard to four that three of them are undoubtedly metallic, but it is possible that the star 1830 Groombridge, which is always looked upon as the star which beats the record in velocity seeing that it would travel from London to Pekin in about two minutes, is not a metallic star.[1]

We are now in a position to make a general summary of the stellar distribution not only in relation to chemistry, but in relation to distance. Taking the chemistry as the basis, we can see what happens to the gaseous, proto-metallic stars and so on, with regard not only to their proper motions, but in regard to the Milky Way.

Summary of Stellar Distribution.

Group.	Proper motion.	Relation to Milky Way.
Gaseous stars	Smallest[2] (Monck)... ...	Condensed in Milky Way (Pickering and McClean)
Proto-metallic	Intermediate (Monck) ...	Brighter ones not notably condensed in Milky Way (McClean)
		Tend to collect in Milky Way, more especially the fainter stars (Pickering)
Metallic ...	Div. 1. Greatest (Kapteyn)	Not condensed in Milky Way (Pickering and McClean)
	Div. 2. Small (Kapteyn)	Collected in Milky Way (Kapteyn)
Mixed flutings	?	?
Carbon ...	?	?

The gaseous stars, which we have seen have the smallest proper motion, are condensed in the Milky Way. The proto-metallic stars, which have but intermediate proper motion, are notably condensed in the Milky Way according to McClean, and tend to collect in the Milky Way more especially with the fainter stars according to Pickering. When we come to deal with the metallic stars, we find that there is no special condensation in the Milky Way. The greater number are not condensed in the Milky Way.

That being so, then, we may take a still further general view. We find that the bright-line stars, the new stars, are almost exclusively in the Milky Way and are far away from us; that the gaseous stars are chiefly in the Milky Way and are far away from us; that the proto-metallic stars are not so confined to the Milky Way, and they are not so far away from us. But when we come to the metallic stars and the carbon stars they have not much obvious connection with the Milky Way, and they are close to us. Unfortunately, with regard to the metallic fluting stars the information is not certain, so that it is best not to say anything about it. Mr. McClean has dealt with a very small number, and he shows that they, like Dunér's stars, the carbon stars, have very little relation to the Milky Way. We thus obtain a tremendous separation between the hot stars with their great distance and the cooler stars with their smaller distance.

But we can go further. As the stars become hot in consequence of meteoritic collisions, we should expect to find nebulous conditions following suit; seeing that nebulæ are masses of meteorites, we should expect to find especially the gaseous nebulæ and results depending upon their presence in the region where the hottest stars exist.

The planetary nebulæ consist of streams of meteorites moving generally in spirals or in circular paths. There is no very great disturbance. We get a bright line spectrum from them, and we know they are practically limited to the Milky Way. We have found that the bright-line stars are limited to the Milky Way; they are simply stars involved in nebulæ. There again we get a connection between the Milky Way and nebulæ. The new stars are due to fixed nebulæ driven into by moving nebulæ, and they are also limited practically to the Milky Way; there again we have the nebulous touch. A piece of work which has not been done, but which badly wants doing, is to see whether those nebulous regions which Sir William Herschel was the first to chronicle have or have not a strict relation with the Milky Way. I have, in fact, made a preliminary inquiry into this matter, and it suggests that these nebulosities are most profusely distributed in the vicinity of the Milky Way just as is the case with the gaseous nebulæ.

(*To be continued.*)

[1] These stars are—

1830 Groombridge	7″·04 ...	Gaseous or proto-metallic.
Σ 2758...	5·196 ...	Metallic.
Σ 578...	4·049 ...	Probably metallic.
D.C. 583	3·7 ...	Metallic.

[2] Kapteyn finds small proper motions for gaseous and proto-metallic stars, but does not separate them into two groups.

SOME REMARKS ON RADIATION PHENOMENA IN A MAGNETIC FIELD.[1]

IN many articles which have recently appeared concerning the work which has been done in the study of radiation phenomena in a magnetic field, I find that, from the historical point of view, there are some statements which are not quite correct, and to which I now desire to attract attention. This appears to me desirable, as it is much easier, and much better, to test and correct errors of statement at the outset than after a lapse of time.

In the first place, it has been very generally accepted that the quartet form which occurs in the magnetic effect was first observed by M. Cornu; but on reference to the enclosed paper (*Trans. Roy. Dublin Society*, vol. vi., series ii., p. 385, read December 22, 1897), you will see that the quartet form,[2] the sextet, and other variations of the magnetic triplet were not only observed, but were photographed and exhibited to an audience in Dublin in the latter end of the year 1897. On the other hand, it was not until the following year (1898) that M. Cornu (working quite independently) announced in the *Comptes rendus* that he had observed the quartet form. Now the *Comptes rendus* being a weekly journal which is widely read, lends itself admirably to the rapid diffusion and circulation of new results, whereas the scientific *Transactions* of a local learned society are slow in appearing and little read or known outside their immediate place of publication. For this reason, the observations of M. Cornu became generally known, while mine remained unknown outside Dublin.

It is true, however, that I endeavoured to have them

[1] These remarks were addressed to Sir Norman Lockyer in the course of a correspondence, and have been thought of sufficient interest for publication.

[2] The quartets are clearly shown, as well as the triplet form, in the plate attached to the paper, and reproduced from the photographs shown at the meeting when the paper was read.

FIG. 1.

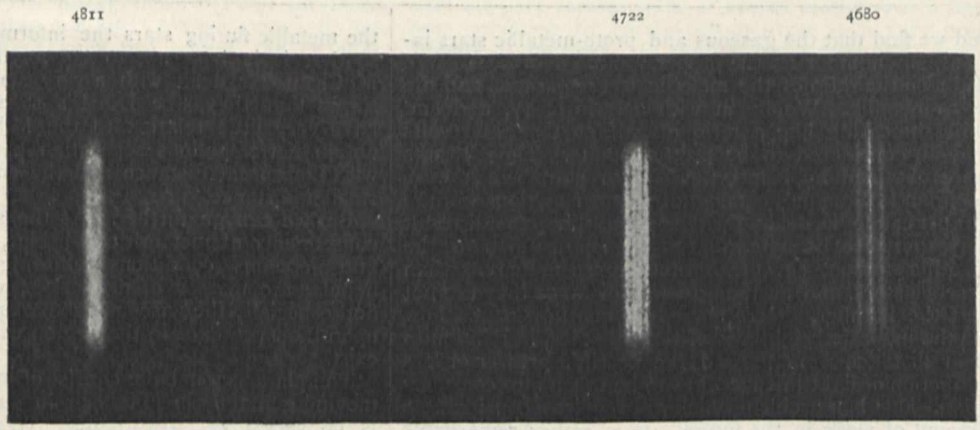

FIG. 2.—Zinc.

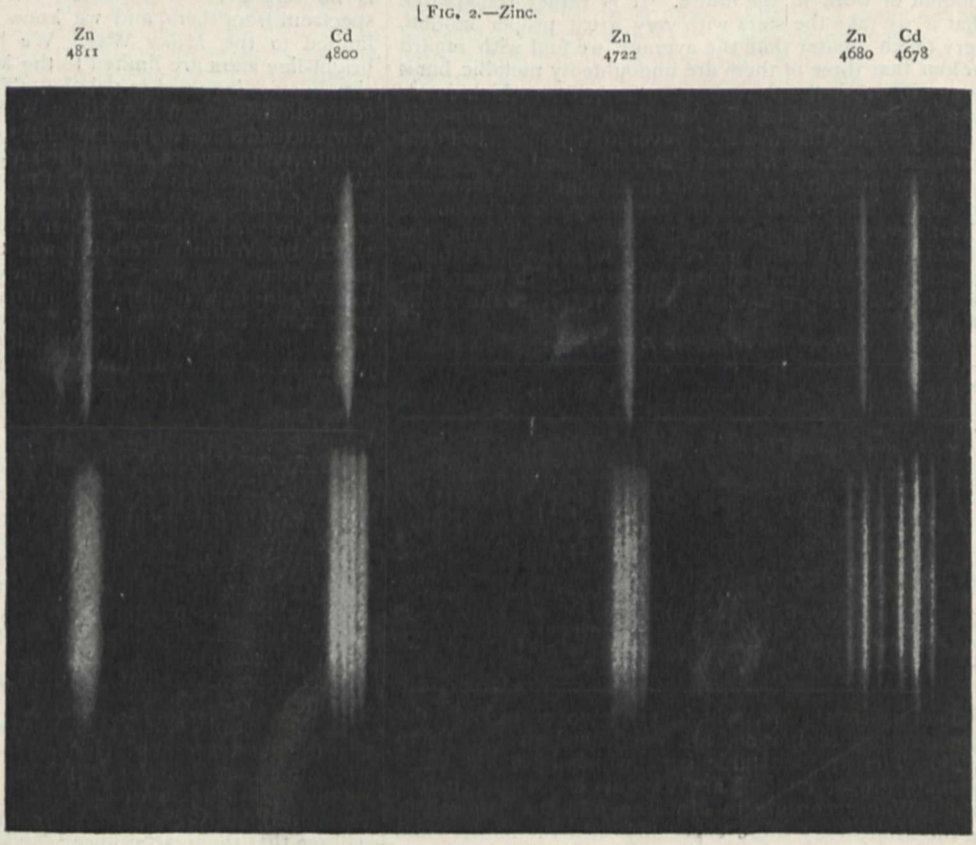

FIG. 3.—Zinc and Cadmium.

EXPLANATION OF PLATE.

In the accompanying plate, Fig. 1 shows the effect produced on the violet line of cadmium 4678. At the top, *a*, we have the line photographed with the magnet unexcited, that is, in the free field. Underneath this, at *b*, the same line is photographed with the magnet excited, but the field is not strong enough to resolve it into its three constituents. It accordingly appears to be merely broadened by the magnetic field. A Nicol's prism was then introduced into the path of the light and the line photographed in the same magnetic field, with the result shown at *d*, where the middle is seen to be removed from the affected line, so that it appears as a doublet. The nicol was then turned through a right angle, and the line again photographed in the same field. The result is shown at *c*, which proves that the sides of the broadened line have been cut off, while the middle has been allowed to pass. This agrees with the supposition that the magnetic field resolves the line into a triplet, but does not absolutely prove it.

The further resolution necessary to prove this point is shown in Figs. 2 and 3. In Fig. 2, a photograph of the zinc lines 4811, 4722 and 4680 is shown, and it will be observed that 4680 shows as a pure triplet, while the others do not. Fig. 3 is a photograph in a still stronger field taken from a spark passing between two electrodes, one of cadmium and one of zinc, so that the lines of cadmium and zinc are obtained simultaneously under precisely the same circumstances. It will be seen that the lines most affected are 4678 of cadmium and 4680 of zinc, and these both show as pure triplets, while the lines 4722 and 4800 show as quartets.

made generally known through the medium of the widely circulated journal NATURE, for on November 19, 1897, I sent photographic negatives to the office of NATURE for reproduction in that journal. These negatives showed the quartets as well as the pure sharp triplets and the diffuse triplets[1] which occur in the spectra of cadmium and zinc. They were produced by me in the end of October 1897, and were, I believe, the first photographic record of the actual magnetic tripling and quadrupling of the spectral lines. These negatives, however, were not considered suitable for reproduction in NATURE (see letter to NATURE, p. 173, December 23, 1897), but were subsequently enlarged and reproduced with great clearness in the *Philosophical Magazine* (April 1898).

In my letter to NATURE accompanying the negatives I did not dwell on the quartet form, as I did not wish to commit myself, or persuade others, to the belief that the quartet was really a magnetic quartet, *i.e.* produced exclusively by the magnetic field. It was quite open to belief at that time that the quartet form might be produced from the triplet by other mechanical causes, for example by reversal of the central line of the triplet, or in other ways, as noticed in my paper mentioned above. After prolonged effort I proved beyond all doubt that these variations of the triplet type (the quartet, &c.) are true magnetic perturbations, and are not due to any other cause; but this required *to be proved*, and for this purpose a very strong magnetic field was necessary.

With this field I found, as already announced in NATURE, that the quartet form becomes resolved into a sextet by the splitting up of the side lines into doublets. It is, therefore, not really a quartet after all, but a sextet.

With regard to other points, namely, the fact that the magnetic effect does not conform to the law deduced by the simple theory (viz. that $\delta\lambda \propto \lambda^2$), and the surmise that some such law might hold for groups of lines, a reference to my first paper, already mentioned (*Trans. Roy. Dub. Soc.*, December 22, 1897), will show both these points clearly emphasised there. On p. 387 I state that while some lines were converted into triplets "others photograph as doublets, or weak middled, greatly broadened lines, having the appearance of quartets; while on the other hand many lines appear to be simply broadened in the same magnetic field, and *others seem to be scarcely influenced in the same magnetic field.*" Thus the effect appeared to be lawless for the spectral lines taken as a whole in any one substance; but I go on to say that "perhaps it might be possible to group the spectral lines of each substance into sets, so that some law of wave-length might apply to the lines of each set."

At this early date I was already seeking for some such law, and I had before the close of 1897 proved that the law, whatever it might be, was *not the same* as that which governs the pressural shift of the spectral lines studied by Messrs. Humphreys and Mohler (see *Proc. Roy. Soc.* of London, January 1898).

My search has resulted in the discovery of a general law which has so far proved to be in complete agreement with all the observed facts.

With regard to the spectrum of iron, you will observe in my note in the *Proc. Roy. Soc.*, January 1898, that I was at that early date of opinion that the spectrum of iron exhibited no peculiarities of its own in the magnetic field. I examined iron early because I thought that by reason of its magnetic properties its spectral lines might show some decided peculiarities (but iron is not magnetic above 700° C., therefore my hopes were not very decided). On the whole I still adhere to that opinion, for although the spectral lines of iron show a variety of effect, yet these effects are the same in character or in kind as those which are observed in other substances. This and other matters I have already treated of fully elsewhere (*Phil. Mag.* and NATURE).

The accompanying illustrations (Figs. 1, 2, 3) have been reproduced from the plate given in the memoir read before the Royal Dublin Society on December 22, 1897. They show that the quartets were observed and photographed by the author certainly before that date.

THOMAS PRESTON.

[1] Really nonets as subsequently determined.

NOTES.

DR. JANSSEN, director of the Meudon Observatory, has issued a circular in which he announces that the success of last year's observations of the Leonid meteors from a balloon has led to arrangements being made to repeat the experiment during the forthcoming shower. Last year, a number of these meteors were observed from a balloon above Paris, though the city itself was at the time enveloped in a thick fog. It is important that numerous observations of the Leonid meteors should be made from as many places as possible; and as balloons render observers independent of cloudy skies, they are evidently of great advantage upon occasions such as that to which astronomers are looking forward. We are informed that two balloon ascents are to take place near St. Denis. The first ascent will be made on the night of November 14-15, with the *Aerostat*, and the second, on the following night, with the *Centaure*. Two seats in each balloon will be at the disposal of Dr. Janssen, who will nominate observers to occupy them, without distinction of nationality. The names of the observers will be announced at the next meeting of the French Astronomical Society, on November 8.

THE opening meeting of the new session of the Institution of Electrical Engineers will take place on Thursday, November 16, when the premiums awarded for papers read or published during the session 1898-99 will be presented, and the president, Prof. Silvanus P. Thompson, F.R.S., will deliver his inaugural address.

A SERIES of monthly lantern lectures has been arranged by the Royal Photographic Society. The first lecture will take place on Tuesday, November 7, when Mr. J. J. Vezey will describe "Some Mediæval Towns of Germany," illustrated with slides by Commander C. E. Gladstone, R.N.

THE death of Mr. Grant Allen, at the age of fifty-one, removes one of the most popular of scientific authors whose writings have induced many readers to watch the workings of animate nature. His first scientific work, on "Physiological Aesthetics," was published in 1877, and was followed, in chronological order, by "The Colour Sense," "The Evolutionist at Large," "Vignettes from Nature," "Colours of Flowers," "Colin Clout's Calendar," "Flowers and their Pedigrees," "Charles Darwin," "Science in Arcady," "The Evolution of the Idea of God," &c. In addition, Mr. Allen contributed numerous articles on natural history topics to periodical literature. All his scientific articles and books are attractively composed, and they have been the means of imparting much popular instruction to general readers.

AMONG the privileges which the Hampstead Astronomical and Scientific Society is able to offer its members is the use of a reflecting telescope of 10½-inch mirror, which is erected in a small observatory on the East Heath, by permission of the London County Council. Interest in practical astronomy is aroused by this means, and the instructive lectures given at the meetings of the Society direct attention to facts and things terrestrial as well as celestial. A course of five lectures on astronomy will be given by Mr. P. E. Vizard in connection with the Society on Monday evenings, commencing on November 20. Mr. Vizard will also lecture on November 10, on the subject of the "November Meteors." A popular interest in, and practical study of, various branches of science is encouraged by the Society, and it is to be hoped that residents of Hampstead are actively supporting its efforts.

THE new session of the Royal Geographical Society will commence on Monday, November 13, when the president, Sir Clements Markham, will give a short opening address, to be followed by a paper by Mr. W. Rickmer Rickmers on his "Travels in Bokhara." The paper at the following meeting, November 27, will be by Mr. Vaughan Cornish on "Desert Sand Dunes." At the December meeting, Colonel Sir John Farquharson will probably give an "Account of the Past Twelve Years' Work of the Ordnance Survey," from the directorship of which he has recently retired. Other papers expected to be given during the session are: "An Ascent of Mount Kenya," by Mr. H. J. Mackinder; "The Work of the Yermak Ice-Breaker in the Spitsbergen Seas," by Admiral Makaroff; "Travels in Central Asia," by Captain H. H. P. Deasy; "Travels in the Region of Lake Rudolf and the Sobat River," by Captain Wellby; "Travels in Abyssinia," by Mr. H. Weld Blundell; and "Anthropogeography of British New Guinea," by Prof. Haddon.

THE *Journal* of the Society of Arts states that artificial paving stones are being successfully produced in Germany. The demand in all larger cities is said to be so good, and the expense attached to their production under former methods is so large, that any improvements on the older systems, whether in saving money or in producing a better stone, will be welcomed by almost all countries. The newest process in Germany is to mix coal-tar with sulphur and warm thoroughly; to the resulting semi-liquid mass chlorate of lime is added. After cooling, the mass is broken into small pieces, and mixed with glass or blast-furnace glass slag. This powder is then subjected to a pressure of 200 atmospheres, and reduced to the form or forms wanted. The resistance to wear and tear in use is fully half as great as that of Swedish granite. Thus it commends itself through durability equal to that of many stone roads, resistance to changes of temperature, roughness of surface—giving horses a good foothold—and, finally, non-transmission of sound. Inasmuch as the joinings are very small, dirt is avoided, and cleaning is very easy.

THE Institution of Mechanical Engineers commenced a series of monthly meetings on Friday last, when a paper was read by Mr. W. Ingham on the incrustation of iron pipes at the Torquay water works. The water supply is obtained from a tributary of the River Teign, which rises in the granite hills on a western spur of Dartmoor. The water is conveyed by two cast-iron mains to Torquay, one of them, laid in 1858, ten inches in diameter. At the time the pipes were laid, no one thought that the pure water from the Dartmoor hills would cause much deleterious action upon them. It was, therefore, with considerable surprise that at the end of eight years the delivering power of the mains was found to be reduced to 51 per cent. of their full discharging capacity. A scraper was designed, several years ago, to clean the pipes, and it is now regularly used. The scraper is pushed forward by the pressure of water acting upon pistons a little less in diameter than the diameter of the pipe. As it moves, the knives press outwards against the inside of the pipe and remove projecting nodules. The movement of the scraper through the pipes can be easily followed, when the mains are about three feet deep, by the rumbling noise it makes. The speed varies, of course, and is on the average about 2½ miles per hour, but a speed of as much as 7½ miles per hour can be obtained for about three-quarters of a mile on one part of the line. After scraping in 1898, the delivery was increased from 586 to 708 gallons per minute, and similar results have been recorded for many years.

WATER engineers have to give very serious consideration to the subject of incrustations upon their mains. The deposit varies, of course, according to the nature of the water conveyed. When the water is derived from wells sunk in the chalk, the coating on the pipes is of pure calcium carbonate, which forms a desirable interior surface from one point of view, if not from the other of reduction of pipe area. Mr. W. Ingham states in his paper to the Institution of Mechanical Engineers that, speaking generally, it may be laid down with a fair approximation to the truth that well waters have not as great an action on pipes as those from upland gathering grounds, but where the water is soft the corrosive action will be greater. Filtered water has also a less corrosive power than unfiltered water. Whatever protective covering is applied to pipes, soft waters will cause rusting within a few years of being laid. At Torquay six years is the outside limit when this commences, so every precaution is taken to see that the pipes are well coated. Mr. Ingham remarks that though much has been done to get a satisfactory coating to pipes, there is still considerable room for improvement, and it is hardly necessary to point out that a fortune awaits the man who can invent something that will withstand the action of soft waters.

THERE seems to be some doubt as to the genuineness of a photograph which has been exhibited at the Royal Photographic Society (picture No. 357), as we gather from a letter published by Lieut.-General Tennant (*The British Journal of Photography*, October 13). Although the writer of this note has not seen the said picture, and therefore cannot describe it, General Tennant refers to it as "a very fine picture of clouds, but I am at a loss to understand how it can have been put forward as being like an eclipse of the sun." He states further that "high in the sky there appears a bright disc partly hiding a dark one surrounded by a bright halo . . . it is as though the bright sun were passing in front of the dark surface of the moon." General Tennant, at the time of writing his letter, stated that he was quite certain that it did not represent any phase of a solar eclipse either at Quetta (the place where the photograph was taken) or elsewhere; but in a more recent communication to the same journal (October 20) he is led to alter his opinion after seeing a photograph of the sun passing behind a church spire, saying that the peculiar appearance may possibly be the result of reversion. The latter opinion of General Tennant is no doubt the correct explanation of the abnormal appearance of the photograph in question, but the photographer of picture No. 357 may be glad to learn that a similar photograph was obtained at Sir Norman Lockyer's camp at Viziadrug, India, during the same eclipse. The camera used was a folding kodak, taking pictures 5 by 4 inches, and the exposures, four in all, were made by a blue-jacket. Each exposure lasted fifteen seconds, but, during the last, totality ended before the given time of exposure was concluded. This photograph shows the small crescent of the sun that appeared from behind the moon as black, while the disc of the moon is not black (as it appeared in the other three photographs), but nearly white, the density being just sufficient to differentiate between the corona and the moon's limb. This photograph is seemingly the same as No. 357, mentioned above, and its peculiarity is due, without doubt, to a reversal caused by the extreme brilliance of the uncovered portion of the sun.

THE photographic process of preparing textile designs, invented by Mr. Jan Szczepanik, was referred to by Prof. R. Beaumont in his opening address at the Yorkshire College, and is described in *Pearson's Magazine*. Prof. Beaumont has personally examined the invention, and has seen designs worked out by the new process in the premises of the Szczepanik Company at Paris. The object of the photographic appliances of Szczepanik is to take the artistic sketch, and, without any modification of the same, to enlarge it to scale, to transfer it on to ruled paper or point paper, and mark it with the thousands and millions of dots arranged in the proper orders for the development of the several parts of the pattern, in the weaves necessary for giving to each suitable precision of character when woven. Prof. Beaumont considers that the apparatus of Szczepanik is capable of producing designs in which there is considerable diversity of woven detail, so that it is purely a question of whether the designs thus obtained are legible for all practical purposes. There must of course be limitations to its utility, as there are to all automatic and mechanical appliances. Yet if it can be employed in accelerating the process of designing large patterns, it should have the serious attention of all who desire the further development of the weaving industries.

FROM a note in the *Journal* of the Society of Arts, it appears that there is reason to believe that in the near future mercury will be one of the most valuable of the numerous metallic products of New South Wales. Native quicksilver was found so far back as 1841 in the Cudgegong River, an auriferous stream, which flows through a portion of the western goldfields of the Colony. Cinnabar had previously been found in the same locality. Though efforts were made by the Rev. W. B. Clark to stimulate systematic research for the metal and its ores, little or nothing was done until later years, when cinnabar was found at several places, the richest deposits being discovered near Yulgilbar, in the Clarence River district, about four years ago. The Government geologist has inspected the workings in this locality, and has definitely ascertained the existence of three parallel lodes, which improve as they go down. Machinery is being erected, and a preliminary testing of about one thousand tons of ore will be made. Should the results prove satisfactory the New South Wales quicksilver trade will become revolutionised, as the poorest assays show the ore to be richer than those of the American and Spanish mines. They will also encourage the search for other cinnabar deposits, which, there is every reason for believing, are more numerous and richer than generally assumed. The value of the discovery in connection with the Colonial gold-mining industry can hardly be over-estimated. It simply means that the work of gold production will become enormously stimulated, thereby greatly increasing the already large auriferous output of the Colony.

THE summary of the *Weekly Weather Report* for the September quarter of the thirty-four years, 1866 to 1899, recently issued by the Meteorological Council, shows that mean temperature for both wheat-producing and grazing districts was 2° above the average. The only variations from these values were in the east and west of Scotland, where the excess was only 1°, and in the south and south-west of England, where the excess amounted to 3°. The general mean of the rainfall for the quarter was 2 inches below the average in both the above-mentioned districts; the principal variations were in the north and east of Scotland, where there was an excess of 1 inch, and in the south-west of England, where the deficiency amounted to 4 inches. Reckoning from January 1, the differences from the averages are less marked; in the east of Scotland, the north-west of England and south of Ireland, the excess amounts to about 2 inches, while in the east and south of England the deficiency amounts to 2·7 and 3·5 inches respectively.

DR. E. S. FATIGATI, of Madrid, has sent us a copy of an interesting pamphlet in which he deals with the representations of plants and animals, agricultural operations, and other natural objects and activities found in very old Spanish tombs, in cloisters of the eleventh and thirteenth centuries, corbels of churches, and choir stalls of the fifteenth century. It appears that the leaves, bunches of grapes, and tendrils of the vine, which were used as decorations during the classic period, are also found in the oldest Spanish sculpture of the sixth and seventh centuries. The animal world is well represented. The swan, the gallinaceous birds, the dog, and the lion make up the fauna of the little Asturian churches of the ninth century. In the magnificent cloister of Silos (eleventh century) the indigenous species are found by the side of those of oriental and northern origin. In the capitals of the cloister of Fawagona (beginning of the thirteenth century) are reproduced in stone two snakes devouring a frog, just as they may be seen doing every day in the ponds of the country. In addition, representations are found of the fight of a hunter with a bear of the Pyrenees, the capture of a hare by an eagle, and many others of the same kind. The pictures of nature with its beings and their struggle for life appear reflected in numerous monuments. From these and many other facts given in the pamphlet it seems that the Spanish sculptures of the Middle Ages have not an exclusive symbolic character, and that in those days Spain was not so separated from nature as many have supposed.

MR. JOHN BRILL, writing in the volume of *Proceedings* of the London Mathematical Society just issued, discusses the complete system of multilinear differential covariants of a single Pfaffian expression and of a set of such expressions. An account of the bilinear covariant of a Pfaffian expression is given by Forsyth; this covariant involves the first set of Pfaffians belonging to the given expression, from which latter it is derived by a differential operation. A repetition of this method upon the covariant itself merely produces an expression which vanishes identically. Mr. Brill shows how, by making use alternately of algebraic and differential methods of derivation, a series of covariants of the given expression can be produced which involve the various orders of derived functions associated with the expression. It is to be noted that the places at which differential operations occur are those which mark the passing from one group of cases into the next in the case of a set of equations obtained by equating the Pfaffian expressions severally to zero. Furthermore, the more general derived functions introduced by Mr. Brill play a similar part in regard to these latter covariants to that which the derived functions of a single expression play in reference to its covariants. One of the main difficulties of the subject is the extraordinary complication of the notation.

AN important paper on the development of the carapace of the Chelonia is contributed by Dr. A. Goette to the last number (vol. lxvi., part 3) of the *Zeitschrift für Wissenschaftliche Zoologie*, in the course of which the disputed question as to the relationship of the leathery turtles (Athecata) to the carapaced chelonians (Testudinata) is discussed. If the views put forward by Dr. Goette are correct, they will profoundly modify the generally accepted views as to the relations of the Athecata and Testudinata—more especially the late Dr. Baur's theory as to the former being a specialised group with a degenerate type of carapace.

IN the August number of the *Transactions* of the Connecticut Academy Mr. W. G. Vanhame records some recent experiments in regard to the fertilisation and development of the Planarians. From the ease with which these creatures can be kept in captivity and the number of eggs laid, observations on the development of the group would appear easy, but difficulties have been met with by previous observers, in consequence of which there are discrepancies and uncertainties in regard to many points. The unusually good preparations obtained by the author have enabled him to throw much new light on some of these disputed points. The eggs are laid in clusters or sheets containing from one to two dozens, arranged in a single layer and closely attached together with a white, mucus-like secretion, which is at first very sticky, although it subsequently hardens, Although hermaphrodite, Planarians reproduce by cross-fertilisation. For the details of the author's observations, reference must be made to the original paper.

IN Prof. Verrill's report on the Ophiuroids collected during the Bahama Expedition of 1893 (*Bulletin from Iowa Laboratory*, vol. v., No. 1), the chief general interest centres round the observations connected with the protective resemblances developed by the feather-stars of the Bahamas. According to the author, "most of these species with long, coiled arms, adapted for clinging to the branches of gorgonian corals, are adapted for imitating closely, in various ways, the forms and colours of the corals on which they live. This must afford them a considerable degree of protection against predaceous fishes, in addition to the direct protection due to the stinging powers of the corals themselves, which is sufficient to cause most fishes to avoid them." Many fishes, it is added, have, however, in all probability become immune against coral-stings, and feed on hydroid polyps; and the author argues that if this be so, the additional protection afforded the feather-stars by their resemblance to the gorgonias would be obvious. But, unless the feather-stars form a specially tempting *bonne-bouche* and are liable to be picked off separately, the obviousness of this does not seem quite clear, since feather-stars and gorgonias would be both consumed together by the fish.

THE importance now attached to preparing skins of small mammals for study purposes according to a uniform plan fully justifies the appearance of a paper on the subject by G. S. Miller in the *Bulletin* of the U.S. Museum (No. 39). A list of instruments and material required, as well as the details of manipulation, are given; and a plate illustrates the appearance of the finished specimens.

THE November number of *Science Gossip* is particularly full of interesting articles. Major B. M. Skinner gives a short account of the valley of the Tochi river which he explored during the North-west Frontier campaign; and an account of the foraminifera collected by him from the rocks in Waziristan is given by Mr. Arthur Earland. The limestones fall naturally into two divisions, (1) alveoline, (2) nummulitic, and the article is illustrated by photographs of rock-sections of both of these types.

A SERIES of observations on the "focal depth," or as it is sometimes called the penetrating power, of microscopic objectives is given by Mr. Leon E. Ryther in the *Journal of Applied Microscopy* for September. By plotting the magnifying powers of various combinations as abscissæ and the corresponding focal depths as ordinates, a curve is obtained approximating to an equilateral hyperbola indicating that in the author's experiments the focal depth varied inversely with the magnifying power.

J. ERIKSSON reprints from the *Annales des Sciences Naturelles* a translation of an important paper, which appeared originally in Swedish, on the brown rust of cereals. He proposes to split up into six species the well-known parasitic fungus *Puccinia rubigo-vera*, only one of which species is at present known in the æcidiospore stage. Of the six species described, the first and second only are of great importance in agriculture, the first being very destructive to rye, and the second being apparently the only parasitic fungus which causes rust on wheat in Europe, the United States or Australia. The paper concludes with some practical suggestions for farmers.

THE mineral resources of the Province of New Brunswick form the subject of Part M of the tenth volume of the annual report of the Geological Survey of Canada (1899). The subject is dealt with by Dr. L. W. Bailey. At the outset he remarks that if we except building-stones, gypsum, limestone, brick-clays, and other materials applicable to building purposes, there are but four substances that have been the basis of anything like extended or successful mining operations. These are coal, iron, manganese and albertite, and of these coal only is at the present time being worked. There are, however, large tracts that are still covered with unbroken forest, and consequently are but little known. They comprise rocks whose geological age and character suggest that they may be productive of useful minerals.

A PROGRAMME of lectures received from the Hull Scientific and Field Naturalists' Club shows that the Club is actively engaged in creating and fostering a love of natural knowledge within its sphere of influence.

DURING this month the following popular science lectures will be delivered on Tuesday evenings, at the Royal Victoria Hall:—November 7, Mr. L. Fletcher, F.R.S., on "The Fall of Stars from the Sky"; November 14, Mr. W. J. Pope, on "The Uses of Distillation"; November 21, Dr. J. W. Waghorn on "Bad-Contacts: their application to telephones and wireless telegraphy"; November 28, Mr. Michael Sadler on "A Brother of the Birds" (St. Francis of Assisi).

THE *London Quarterly Review* (Charles H. Kelly) publishes a long article by "A Field Naturalist," in which Darwin's observations and experiments on cowslips and primroses are discussed, and the conclusion is arrived at that the evidence brought forward by him is insufficient to establish the theory that cross-fertilisation is necessary to the full fertility of flowers. "On the contrary," says the reviewer, "we are of opinion that the primrose gives strong confirmatory evidence to Axell's view, that under natural and equal conditions, self-fertilisation of flowers is both the legitimate fertilisation and the most productive."

A NATURAL consequence of the scientific activity of the Liverpool Marine Biology Committee is the preparation of a series of memoirs, edited by Prof. Herdman, on typical British marine plants and animals. Each memoir will be concerned with one type, and the forms selected for description will chiefly be common Irish Sea animals and plants, of which no adequate account already exists in text-books. Three of the memoirs will appear before the end of this year, namely, Ascidia, by Prof. Herdman; Cockle, by J. Johnstone; and Echinus, by H. C. Chadwick. Others will follow in rapid succession, and the complete series of special studies promises to be of value to all marine biologists.

THE additions to the Zoological Society's Gardens during the past week include a Sooty Mangabey (*Cercocebus fuliginosus*) from West Africa, presented by the Rev. A. Clutterbuck; a Young Leopard (*Felis pardus*) from East Africa, presented by Captain J. L. Stanistreet; a Greater Vasa Parrakeet (*Coracopsis vasa*) from Madagascar, presented by Mr. C. Hunt; a Corn Crake (*Crex pratensis*), British, presented by Mr. Collingwood Ingram; a Ring-hals Snake (*Sepedon haemachetes*) from South Africa, presented by Mr. J. E. Matcham; two Red-footed Lemurs (*Lemur rufipes*, ♂ ♀) from Madagascar, an Ichneumon (*Bdeogale*, sp. inc.) from Africa, a Westerman's Eclectus (*Eclectus westermani*) from Moluccas, two Black-tailed Godwits (*Limosa aegocephala*), European; ten Salt-water Terrapins (*Malacoclemmys terrapin*) from North America, deposited; four Common Squirrels (*Sciurus vulgaris*), European, purchased.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN NOVEMBER:—

November 6. 0h. Conjunction of Saturn with the moon, ♄ 1° 1′ N.

11. Saturn. Outer minor axis of outer ring = 16″·11.

12. 11h. 11m. to 11h. 29m. Occultation of κ Piscium (mag. 5) by the moon.

12. 20h. Jupiter in conjunction with the sun.

14–16. Expected brilliant return of the Leonid meteoric shower.

15. Venus. Illuminated portion of disc = 0·966.

15. Mars. Illuminated portion of disc = 0·991.

16. 4h. Mercury at greatest eastern elongation (22° 18′).

17. 10h. 21m. to 11h. 29m. Occultation of A[1] Tauri (mag. 4·5) by the moon.

19. 6h. 10m. to 7h. 1m. Occultation of Neptune by the moon.

19. 10h. 32m. Minimum of Algol (β Persei).

22. 7h. 21m. Minimum of Algol (β Persei).

25. 14h. 11m. to 15h. 21m. Occultation of 55 Leonis (mag. 6) by the moon.

HOLMES' COMET (1899 *d*).

Ephemeris for 12h. Greenwich Mean Time.

1899.	R.A. h. m. s.	Decl. ° ′ ″
Nov. 2	2 36 36·67	+49 14 8·0
3	35 23·08	12 57·8
4	34 9·70	11 24·8
5	32 56·63	9 29·5
6	31 44·00	7 12·1
7	30 31·92	4 33·0
8	29 20·51	49 1 32·6
9	2 28 9·89	+48 58 11·4

COMET GIACOBINI (1899 *e*).—The following ephemeris is given by Herr S. K. Winther, of Copenhagen, in *Astr. Nach.*, Bd. 150, No. 3598:—

Ephemeris for 12h. Berlin Mean Time.

1899.	R.A. h. m. s.	Decl. ° ′	Br.
Nov. 2	17 18 59	+4 42·4	0·66
3	20 33	4 58·6	
4	22 8	5 14·8	
5	23 43	5 31·0	0·63
6	25 18	5 47·1	
7	26 53	6 3·3	
8	28 29	6 19·4	0·60
9	17 30 5	+6 35·6	

NEW ALGOL VARIABLE IN CYGNUS.—The following *minima* will occur at convenient times for observation during November:—

$$\text{D.M.} + 45^\circ \cdot 3062 \begin{cases} \text{R.A. 20h. 2·4m.} \\ \text{Decl.} + 45^\circ\ 53' \end{cases} (1855).$$

	d.	h.	m.
1899. Nov.	6	8	57
	15	12	27
	29	5	43

NEW VARIABLE STAR.—In the *Astronomical Journal*, No. 470, Mr. R. T. A. Innes, of the Cape Observatory, gives the individual results of his observations leading to the detection of a new variable. Its position is:—

$$\text{C.P.D.} - 54^\circ \cdot 6634 \begin{cases} \text{R.A.} = \text{15h. 32m. 42s.} \\ \text{Decl.} = -54^\circ\ 54' \cdot 4 \end{cases} (1875).$$

The star was first suspected of variability by Prof. J. C. Kapteyn, who furnished a list of possible variables to the Cape Observatory in December 1896. Mr. Innes, from a discussion of the *fifty-eight* observations he records, finds the period to be about 12·68 days, the variation of magnitude being from 8·7 to 9·3. The fall to, and rise from, minimum seem to be very sharp; but notwithstanding this similarity to the Algol type, it is not considered likely to belong to that class. The colour of the star is distinctly red.

GEOGRAPHY AT THE BRITISH ASSOCIATION.

THE Dover meeting was characterised by the unusual quantity of solid work in physical geography and mainly in oceanography, including polar research, which was brought before the Section. Travel papers were less numerous than usual, though certainly of no inferior type, and the use of the lantern to illustrate nearly every communication added both to the interest and the value of the expositions. The hall was ill-situated and not well adapted for the purpose it was called upon to serve, and this unfortunate environment, not any falling off in the quality of the papers, accounted for the remarkably small audiences, which were the subject of general remark.

The address of the President, Sir John Murray, contained a summary of existing knowledge as to the ocean floor, and concluded with indications as to the direction in which advance during the immediate future is to be looked for. In this respect Sir John Murray gave prominence to the improved prospects for Antarctic research, and emphasised the importance of the forthcoming expeditions aiming at scientific completeness in their work. In seconding the vote of thanks for the address, Sir Michael Foster, the President of the Association, spoke of the interest which the Royal Society as well as the Royal Geographical Society felt in Antarctic exploration, and of the determination of both Societies to make the best possible use of the funds which might be placed at their disposal for the complete scientific study of the south polar area.

ARCTIC PAPERS.

The most recent results of Arctic exploration were described by three explorers who had attacked the problem in very different ways. Admiral Makaroff, of the Russian navy, gave an account of the trial trip of the great Russian ice-breaker *Yermak*, a vessel recently constructed at Armstrong's works on the Tyne for service in the Baltic during winter and in the Kara Sea in summer. The vessel is built of steel, the plates being very heavy and the ribs and cross-girders of very great strength arranged to meet the thrust of ice from all sides. She is built with two hulls, one within the other, is minutely subdivided into water-tight compartments, and fitted with an elaborate system of tanks and steam-pumps which enable the trim of the vessel to be altered very rapidly. Thus the vessel may be depressed at bow or stern, or canted to port or starboard by pumping water from one set of tanks to another. The displacement of the vessel fully equipped is 8000 tons, and her engines have power by acting on three propellers at the stern to drive her at the rate of 14 knots. A fourth propeller at the bow, intended to drive away the broken ice by the currents it generates, was found useful only in light ice, but of no value in breaking ice of great thickness. The trial-trip, which Admiral Makaroff described with many illustrations from photographs, demonstrated the power of the ship to break away through ice as much as 14 feet thick, not so much by smashing the ice as by determining the direction of cracks by which the mass is split. A cinematograph picture was obtained of the *Yermak* forcing her way through the thickest of the Arctic pack-ice north of Spitsbergen, but Admiral Makaroff regretted that the film could not be developed in time for exhibition at the meeting. During the trip the ice was not only broken to make way for the ship, but studied minutely. The powerful derricks with which the vessel is fitted made it possible to capsize large blocks of ice so as to study the parts normally under water, and also to hoist on deck masses of many tons weight, to be studied as to temperature by the insertion of thermometers to different depths, and as to chemical composition, melting point, &c. Admiral Makaroff is convinced of the perfect suitability of strong steel ships for polar research; and in reply to an inquiry as to whether he hoped to reach the North Pole in the *Yermak*, said that he only wished he might be allowed to try. There was a long discussion on the paper, in which the value of this new method of mastering the ice was generally recognised.

Mr. W. S. Bruce, who had just returned from a voyage to Spitsbergen in the Prince of Monaco's yacht, *Princesse Alice*, gave an account of the physical and biological conditions of the Barents Sea, founded on that cruise and on a voyage last year in Mr. Andrew Coats' yacht *Blencathra*. Only two of the many current floats thrown overboard by the *Blencathra* had as yet been recovered.

Mr. Walter Wellman, in an address on his recent journey to

Wilczekland, dwelt upon the motives and methods of Arctic exploration, advocating the "dash for the pole" as the only practical method of attaining the highest latitude in the short time available during the brief season available for travelling in the Far North. He recounted the incidents of his attempt in 1898-99, which was unsuccessful on account of a serious accident which befel him when camping on an iceflow which was broken up by a sudden pressure.

ANTARCTIC PAPERS.

The records of recent work in the Antarctic were of no less interest, and the display of slides from Antarctic photographs was unique, none of them having been shown in public before.

A short account of the cruise of Sir George Newnes' yacht *Southern Cross*, with Mr. Borchgrevink and his party on board, from Hobart to Cape Adare, was communicated by Dr. H. R. Mill, and illustrated by a few pictures of the Antarctic ice and of the landing at Cape Adare. The *Southern Cross* left Hobart on December 19, reached 50° S. on the 23rd. The first ice was met with on the 30th in 61° 56′ S., and 159° E., and on January 1, 1899, she was practically stopped by the pack in 63° 40′. Every effort was made to proceed southward and eastward, but with small result, as on January 31 the position was only 66° 46′ S. and 165° 28′ E. She then commenced to work northward and eastward to escape from the pack, which she did on February 12 in 65° 43′ S., and then it was found easy to cross the pack to the southward in longitude 173° E., the ship anchoring off the beach at Cape Adare on February 17. Tempestuous weather was experienced, the wind at the most southerly part of the voyage blowing usually from easterly and southerly quarters, and the vessel being more than once in danger of driving ashore. Stores were landed, huts erected, and the *Southern Cross* finally left Mr. Borchgrevink with nine companions and seventy-five dogs on the shore of what he believed to be the Antarctic continent on February 28, 1899.

M. H. Arçtowski, the oceanographer and meteorologist of the *Belgica*, gave a brief account of the voyage and the wintering of the Belgian expedition in the Antarctic ice-pack south-west of Cape Horn. He showed a number of photographs of the newly explored land, and concluded by expressing his views as to the further work required in Antarctic exploration as follows:—

At the present day it is impossible to consider the land alone; the whole Antarctic area exhibits phenomena which remain very imperfectly known, such as the great questions of atmospheric circulation, climate, circumpolar oceanography and magnetic conditions. Hence Antarctic explorations must be conducted in three ways:—

(1) A system of fixed stations arranged between the edge of the continents and the zone of ice. These stations should be supplied with all necessary magnetic and meteorological instruments, and continue at work simultaneously for one year at least.

(2) During the same year two polar expeditions should set out on opposite sides towards the South Pole. This would require two vessels strong enough to withstand the pack, and equipped for wintering.

(3) Finally a circumpolar expedition, planned to follow the edge of the pack right round, and specially equipped for oceanographical and zoological work. This expedition would also survey the accessible parts of the Antarctic coast.

Such a system of exploration must necessarily be the work of several nations. Weyprecht's idea should be revived and followed. Antarctic exploration must be conducted systematically, and it ought to be international. A series of circumpolar stations, where comparable and simultaneous observations are carried on, would make the results of the British and German Antarctic expeditions remarkably complete, and vastly enhance their value.

A polygon of stations should unite South America and the Antarctic lands. The path of the cyclonic storms passes to the south of Cape Horn, and—at least during part of the year—to the north of Palmer Land. The polygon should include stations on the east and west coasts of Graham Land, and one of the South Shetland Islands, on South Orkney and on one of the Sandwich Islands, together with stations at Cape Pillar, Cape Virgins, Cape Horn, Staten Island and the Falklands. With such a system of observation it would be possible to determine exactly the track of every cyclone crossing the polygon of stations. This is a matter of very great practical importance. These cyclones seem to travel in the general direction of the upper winds from west to east, and they seem to follow the outline of Alexander, Graham and Palmer Lands, but how and why this is so we cannot tell as yet. Between South America and the Antarctic land there is a belt of low pressure which seems to encircle the Antarctic region where there is apparently a permanent anticyclone; but observations are wanting to determine the associated conditions of atmospheric circulation.

It seems scarcely necessary to insist on the advantages which two other polygons of stations would present, one to the south of the Indian Ocean, the other between New Zealand and Victoria Land. The second polygon would be formed by the islands of Prince Edward, Crozet, Kerguelen and a station on Enderby Land. The third polygon would include the Balleny, Macquarie and Auckland Islands. This would be a particularly interesting polygon on account of its comparative proximity to the magnetic pole.

The two vessels designed to winter in the pack should approach along the meridians of 145° W. and 35° E. Imprisoned in the pack as the *Belgica* was, these vessels would be able to carry on oceanographical and zoological work, and also to collect magnetic and meteorological observations, thus adding two stations near the pole to the various polygons. From the meteorological point of view it would be extremely interesting for these vessels to reach high latitudes, for the region near the pole will probably differ greatly from the northern edge of the Antarctic lands in everything regarding atmospheric pressure, wind and storms.

As to the circumpolar expedition, the vessel intended for this purpose should be quite independent of those which penetrate the pack. The region is too great to admit of the whole voyage being completed in one season—three would probably be necessary. It is not easy to indicate the route which should be followed, for everything depends on circumstances. Still, it may be observed that—in summer at least—easterly winds predominate near the edge of the south polar pack, and therefore it would be advantageous to proceed from east to west.

Mr. J. Y. Buchanan, F.R.S., treated of the physical and chemical work required for an Antarctic expedition, and pointed out that the principal object at the outset of the expedition should be to push energetically southwards, and effect a landing in the most suitable place in the highest possible southern latitude, and there establish the principal station. The locality should be chosen where the ship, or one of the ships, would find safe winter quarters. As the principal object is to establish the expedition as advantageously as possible on land, no time should be spent unnecessarily at sea. For this reason magnetic observations at sea should not be contemplated. They take up an enormous amount of time, and besides, if they are to be of any use, the distribution of iron in the ship has to be arranged under such restrictions as to interfere materially with the usefulness of the ship in other directions. On land, the magnetic observations would occupy a first place, also pendulum observations for the determination of the intensity of gravity and tidal observations. It has been the general experience of Antarctic navigators that the heavy pack-ice is met with at a considerable distance from land, and between it and the land there is comparatively open water. The ice which would cover this water in winter would probably loosen earlier than the heavy pack, and the ship, if wintering inside, might be able to move much earlier than it would be possible for her to pass the pack; and this would be an additional advantage of finding winter quarters for the ship.

Perhaps the most important work to be done is to obtain a complete meteorological record during the whole of the sojourn of the expedition in Antarctic regions, whether at sea or on land. At present, any view as to the meteorological conditions on the Antarctic land may be held, because we have no facts by which to regulate our speculations. The expedition should be fully supplied with instruments for this purpose, and especially with self-recording instruments. As the station must necessarily be on land, and not on ice, geological observations will be made as a matter of course.

What distinguishes the Antarctic regions above everything is the development of ice as a geological feature, whether it is met with at sea as icebergs, or on land as glaciers, or a continuous covering. It is almost certain that any station on land will be within easy reach of a glacier, and means should be taken to establish marks as early as possible which will enable its motion to be observed before darkness sets in and after the sun reappears.

The Greenland glaciers appear to move about three times as fast as the Swiss ones. Do the Antarctic ones move faster still? In Spitsbergen the glacier streams sometimes take very large proportions. How does it stand with the Antarctic ones in this respect? The "grain" of the Spitsbergen glaciers does not seem to be larger than that of the principal Swiss glaciers. The Antarctic land ice must be dissected with a view to the determination of the size and the articulation of the grain. It is, therefore, of the first importance that the chemist and physicist should have spent some time, both in summer and in winter, examining for himself the conditions of one of the Swiss glaciers. This is quite as necessary for him as having spent a certain time in a chemical or a physical laboratory.

The papers on Antarctic exploration gave rise to an animated discussion. Prof. Rücker, speaking of the requirements for magnetic work, expressed his preference for observations on board a wooden ship cruising round the Antarctic, to the concentration of observations on a few fixed stations; although he allowed that excellent results could be obtained from fixed stations if they were numerous enough, and not established upon magnetic rocks; series of well-distributed stations being more important than a position in high southern latitudes or equipment with apparatus of remarkable delicacy. Major Darwin observed that such differences of opinion as had been expressed regarding the work to be attempted in Antarctic exploration arose simply from the want of funds to provide for the complete representation of all departments; and he indicated two guiding principles. (1) If a special Antarctic ship is to be built, it should spend the whole of the available time in the Antarctic regions proper. (2) The greatest unknown feature should be selected for study; that is, the Antarctic continent. For any kind of south polar expedition it is of the utmost importance to select the scientific staff with the greatest possible care. Mr. George Murray said that he had been carefully studying the question of the cost of ships, and had come to the conclusion that for two well-equipped vessels, each with an adequate scientific staff, a sum of 150,000*l.* would certainly be required. Dr. Koettlitz laid stress on the importance of expert supervision in the preparation of all the tinned foods of an expedition. Sir John Murray, in summing up the discussion, said it was plain that for a proper study of the Antarctic regions two ships would be required, one specially designed for magnetic work and for penetrating the ice, the other equipped for circumpolar oceanographical observations.

OCEANOGRAPHICAL PAPERS.

Dr. Gerhard Schott, of the Hamburg Marine Observatory, the oceanographer of the German deep-sea expedition, gave an account of the chief results of the voyage of the *Valdivia*, illustrated by many photographs, including some fine pictures of tabular and peaked Antarctic icebergs. The expedition, sent out at the expense of the German Government, was practically a circumnavigation of Africa, though in wide curves including the invasion of the Antarctic region to the edge of the pack-ice off Enderby Land. Apart from the exploration of the edge of the southern ice and the rediscovery of Bouvet Island, the cruise was of great geographical importance on account of the exact oceanographical study of the whole of the tropical Indian Ocean for the first time. The oceanographical results include deep-sea soundings carried out with two different machines, one the Sigsbee, of American manufacture, which acted remarkably well, even in very stormy weather.

The utilisation of an electromotor for winding up the wire was a new and very successful application much to be commended, especially for polar work, when steam-pipes are apt to freeze. The most important soundings were those made between Capetown and Bouvet Island, thence southward to the edge of the ice, and eastwards along the margin of the pack, and thence north to Kerguelen. This region had previously been almost unknown. During this part of the trip great attention was paid to ice-conditions, the ice being distinguished into *Drift-ice*, consisting of low fragmentary masses, often obviously portions broken off glaciers; *Pack-ice*, greenish stratified masses of frozen sea-water; and *Icebergs*, which in the east near Bouvet Island were rugged, much waterworn, and had obviously come from a distance; while in the east, near Enderby Land, they were tabular in form, quite fresh and unworn: their height was usually from 100 to 180 feet. The meteorological conditions were also studied throughout the cruise with great care.

Mr. H. N. Dickson discussed the observations of temperature of water and air round the British Islands. The mean monthly and annual temperatures of the surface waters of the sea during the period 1880–97 are shown for sixty-five stations distributed round the coasts of England, Scotland and Ireland. The average for the year at the entrance to the English Channel is nearly 54° F., it falls as the Channel narrows to 52° between the Start and Cape la Hogue, and remains steady to beyond the Straits of Dover, at least as far as the East Goodwin light-vessel. On the south-west coast of Ireland the annual mean is about 52°, falling to 51° in St. George's Channel, and 50° in the Irish Sea. A slow fall from 52° to 50° takes place on the west coast of Ireland until the N.W. corner is reached. The mean of 49° persists along the north coast of Ireland to the North Channel, and along the whole of the west coast of Scotland to Stornoway. On the east coast temperature falls very quickly, as soon as we get out of range of the Straits of Dover, to 50° off Suffolk and Norfolk, and then there is a gradual fall northwards, to 48° off the coast of Northumberland, 47½° off Aberdeenshire, and 47° at the Orkneys and Shetlands. The effect of the tidal streams in mixing the waters is exceedingly well marked. The annual minimum of temperature rarely occurs in March, most frequently in January, especially at stations open to the Atlantic. The annual maximum occurs almost everywhere in August.

Mean temperatures of the surface water are compared with the forty-year averages for the air, recently published by Buchan. A comparison shows that the mean annual difference has hitherto been somewhat over-estimated, especially on the western coast; in no case is the mean excess of sea over air greater than 2° F. The maximum difference occurs everywhere in November and December, and is greatest on the south coast of England between Portland Bill and the Straits of Dover.

Mr. Dickson also contributed a paper on the temperature and salinity of the surface water of the North Atlantic during 1896 and 1897. The completed series of forty-eight monthly charts of surface temperature and salinity, the mode of construction of which was described in a paper read before the Section last year, was exhibited, and along with it maps showing the departures from the mean distribution of air pressure and temperature during the same period. A number of new features in the movements of surface waters were disclosed, notably in connection with the distribution of polar waters from the western Atlantic.

Dr. H. R. Mill suggested a system of terminology for the forms of sub-oceanic relief. He said that the fact that the forms of the ocean floor cannot be seen, but only felt out by soundings, makes their study one of peculiar difficulty. Some distinguished authorities believe that our present knowledge of the deep sea is too slight to justify any systematic terminology. Meanwhile each investigator introduces a set of names of his own, for the most part based on analogies with land forms visible to the eye. It is obvious that there are two great classes of forms, elevations above and depressions below the general level of the ocean floor; but the question is how many subdivisions of each can be recognised as distinctive and deserving of generic names. The following general scheme of terminology is put forward tentatively, premising that no attempt be made to localise any precise type of form unless a considerable number of soundings exist to define it:—

Depression—The general term for any hollow of the ocean floor. *Basin*—A relatively wide depression, with comparatively gently sloping sides. *Caldron*—A relatively wide depression, with comparatively steeply sloping sides. *Furrow*—A relatively narrow depression with comparatively gently sloping sides. *Trough*—A relatively narrow depression with comparatively steeply sloping sides. *Wall*—Any submarine slope comparable in steepness to a precipice on land. *Floor*—Any very gentle submarine slope or nearly level surface. *Elevation*—Any inequality above the general level of the ocean floor. *Rise*—A relatively narrow elevation. *Bank*—A relatively wide elevation. *Shoal*—An elevation coming within five fathoms of the surface, so as to be a danger to shipping. *Shelf*—A nearly horizontal bank attached to the land and bordered seaward by a much more abrupt downward slope.

Mr. C. W. Andrews, in a paper on the relation of Christmas Island to the neighbouring lands, referred to the peculiarities of the geology and biology of the island, and traced the resemblances which seemed to associate it with the Cocos-Keeling group on one side and Java on the other. The occurrence of earthworms in Christmas Island was an anomaly in the biology of oceanic islands, and difficult to explain.

Sir John Murray and Mr. Robert Irvine discussed the distribution of albuminoid matter and saline ammonia in sea-water; and Sir John Murray with Mr. F. P. Pullar exhibited and described the sounding-machine they employed in their bathymetrical survey of the fresh-water lakes of Scotland, and gave an account of the configuration of the beds of the lakes of the Loch Katrine group. The authors expressed their intention of extending the work to the other lakes in Scotland, although they felt that it was rather for the nation than for individuals to carry out work of the kind.

OTHER PAPERS.

Colonel Sir John Farquharson, late Director General of the Ordnance Survey, gave an account of the progress of the work of that department during the last twelve years, and exhibited a number of illustrative diagrams and specimen maps. He said that during the twelve years (1887-99) there have been probably more changes made in the character of the work done by the Survey than in any other equal period of its history; and, as regards the areas covered by its operations, they have been largely in excess of the areas covered during any previous equal period. This is, of course, due to the fact that revisions have now largely taken the place of original surveys. The most important advances made were:—

The progress (to completion in 1890) of the original cadastral survey of England and Wales, including the 6-inch surveys of uncultivated districts. The progress made on re-surveys for the larger scales of various counties of England and Scotland which had been originally surveyed for the 6-inch scale only; and the progress made on the revision of the original cadastral surveys of England and Scotland, whether on the 25-inch or 6-inch scale. The progress made on the re-survey of Ireland for the $\frac{1}{2500}$ or 25-inch scale. The progress made on the completion of the original new series engraved 1-inch maps of Great Britain and Ireland, both in outline and with hills. The progress made on the revision of the new series of 1-inch engraved outline maps of Great Britain and Ireland, and the commencement of the issue for Scotland and the North of England (and for Ireland ultimately) of the same revised 1-inch map with hills in brown by double printing. The progress made with coloured 1-inch maps of the South of England. The progress made with maps on scales smaller than 1 inch to a mile.

A short account was given of the nature, causes, and results of the changes made since 1887 in the system of carrying out the survey, some of which were due to the reports of committees, or suggestions from the general public, while others have been necessitated by the changes which have taken place in the character of the work done by the Department.

The Ordnance Survey Department, in 1887, published town maps at the cost of the State, on the scales of 10 feet ($\frac{1}{500}$) and 5 feet ($\frac{1}{1056}$) to a mile. It does so no longer. The reason for this change was stated. The sales of the Ordnance Survey maps were in 1887 in the hands of the Stationery Office; they are now in the hands of the Ordnance Survey Department itself. The reasons for and results of this change were stated.

Some remarks were also made as to the organisation and superintendence of the department and of its work; as to the use made of the Ordnance Survey maps by other departments of the State and by the public generally; and as to the important work which still remains to be done by the Ordnance Survey.

Mr. Vaughan Cornish described the sand-dunes bordering the delta of the Nile dealing with the ripples, sand-dunes, and dune-tracts in turn.

Ripples.—The author had previously measured twelve wind-formed ripples in the blown sea sand on the Dorset coast. The average ratio of length to height was L/H = 18·4. The least height was ·06 inch, and the greatest ·34 inch. These measurements were, for the most part, of one or two individual ripples. Mr. E. A. Floyer measured six of the largest kind of ripples on the El Arish route, and obtained L/H = 17·7 with H from 6 to 10·6 inches. The author measured thirty-seven *consecutive* ripples to leeward of a sand-dune near Ismailia. The ripples had an average height of 1·43 inches, and the average L/H was 16·57. The appearance of these was intermediate between that of ripples where accumulation is rapid (which never grow large), and the large and nearly symmetrical ripples (? analogous to sastrugi), as much as 11 feet in wave-length, the formation of which is apparently accompanied by a considerable lowering of the general level.

Dunes.—A tract of a few hundred acres of small, but true, dunes (not ripples) on a sandy foreland, exposed during the fall of the Nile, afforded an opportunity for similar measurements.

Higher and lower dunes succeeded one another, and, viewed transversely, the ridges were strongly undulating. Nevertheless, a line having been marked out in the up-and-down-wind direction, the *average* L/H for twenty-four consecutive dunes was found to be 18·04, average height 20 inches. Another set of measurements taken near the same line on the succeeding day gave L/H = 17·89 for twenty-three consecutive dunes. Apparently the ridges are formed of the nearly uniform (L/H = 18) shape, and lateral inequalities are subsequently developed in the manner explained in the *Geographical Journal*, June 1898, pp. 637–9, but these do not affect the *average* L/H. The author hopes to make similar measurements of trains of larger dunes.

The straight, slipping lee cliff of dunes is caused by the under-cutting of the eddy. In the dunes near Ismailia a progressive development of the profile form was observed. At first both windward and lee slopes are very gentle, and the highest point is near the middle. The summit apparently moves to leeward, and the lee slope becomes steeper; a slipping cliff is formed on the upper part of the lee slope. This pushes back towards the summit, and the windward slope grows steeper. Finally, windward and average leeward slope become of nearly equal steepness, and the top of the cliff coincides with the summit of the dune.

Dune Tracts.—The condition for formation of a dune tract in a sandy district is that the rate of travel of the sand should be locally diminished without a corresponding diminution in the supply of sand. The persistence of such a condition may cause a stationary dune massif without fixation.

In the sandy district visited by the author the formation of a dune tract or dune massif appears to be chiefly determined by the presence of ground moisture, which gives coherence to the sand. Thus the boundaries of these massifs frequently appear inexplicable when an explanation is sought in the wind. Within the bounds of the massif, however, the modelling of the surface is explicable by the action of the winds. In the neighbourhood of Helwan, wind erosion of limestone and other rocks is very active over areas where there are no dunes. An examination of the wind-formed detritus showed a quantity of sand-sized particles sufficient for the formation of dunes; and the explanation of their non-formation seems to be that the sand-sized particles are too small a *proportion* of the whole. According to this line of reasoning, dunes will only be formed where dust formation proceeds slowly, for if dust be produced rapidly the proportion of sand-sized particles remains low.

Travel papers, for the most part accompanied by graphic illustrations, were contributed by Mrs. W. R. Rickmers on the rarely visited region of Eastern Bokhara, by Mr. W. R. Rickmers on the Karch-Chal mountains in Transcaucasia, by Dr. H. O. Forbes on the island of Sokotra, by Mr. O. H. Howarth on the province of Oaxaca in Mexico, by Dr. A. C. Haddon on some geographical results of the recent Cambridge anthropological expedition to the Malay Archipelago and New Guinea, and by Captain Wellby on a remarkable journey through the western borderlands of Abyssinia. Mr. E. Heawood contributed a paper on the date of the discovery of Australia, in which he brought forward evidence for discrediting the rumours of the discovering of Australia in the fifteenth century or the early part of the sixteenth.

The eighth report of the Committee on the Climatology of Tropical Africa was presented, giving records from forty stations.

MECHANICS AT THE BRITISH ASSOCIATION.

MEETING under the presidency of Sir William White, Chief Constructor of the Navy, naturally the papers which came before the Section dealt mainly with marine engineering, canal and harbour works, and allied subjects.

Owing to the energy of the President a very complete programme was secured; and the papers read and discussed were certainly considerably above the average. The attendance at the sectional meetings was also much better than usual.

On the opening day, after the presidential address, a paper by Messrs. Coode and Matthews on the Admiralty harbour works at Dover was submitted to the Section. It was taken early in the programme in order that the engineers present at the meeting who naturally wished to carefully inspect the magnificent works now in progress at Dover, which will render that port one of the finest in the kingdom, should hear beforehand an account of what it is intended to do from the engineers responsible for the design. In the discussion the difficulties which have been brought about by the more rapid advance of the Commercial Harbour Pier, as compared with the extension of the Admiralty Pier, were much in evidence; but this, after all, is only a question of a more or less ephemeral character, and it is a pity that the discussion did not turn more upon the merits of the particular plan which has been adopted in the construction of this great harbour. It is noteworthy that the general scheme of the present plan differs but little from previous proposals; only that additional deep-water space has been obtained.

If the sanguine expectations of the people of Dover are in any way fulfilled, Dover on the completion of these works will prove a formidable rival to Southamption; before, however, any such rivalry can become serious, Dover must be provided with a railway service on an entirely different scale from that now supplying the wants of the town. The service is inadequate; it is frequently unpunctual, and contrasts most unfavourably with the splendid service which the South-Western Company have organised between Southampton and London.

The other paper taken on the opening day was one descriptive of a process for rendering wood non-flammable. Specimens of wood treated by this process were exhibited, and a practical demonstration of its non-flammability was given at the meeting. The President mentioned in the discussion that the Admiralty have not been satisfied with other people's experiments; they have themselves experimented on wood treated in this way, and have satisfied themselves that the process is a successful and valuable one. It is, however, not only in ships of war, but also in passenger steamers and in the gigantic modern hotels that the use of non-flammable wood will have its application, in spite of the extra cost of the finished wood when treated by this process.

On Friday a paper prepared by Sir Charles Hartley, descriptive of the engineering works of the Suez Canal, was read by Sir John Wolfe Barry in the absence of the author. This paper was one of the greatest interest, giving a complete history of the engineering features of the canal, of the enormous growth of the traffic through the canal, and of the gradual steps which have been taken to provide for that increased traffic, both by widening and deepening the original cutting. How great a change has been brought about in the time of transit by the use of the electric light for enabling night passages to be made can only be realised by a study of the figures given by the author as to the present time of transit compared with what it was ten years ago.

The second paper on Friday was the one that proved, perhaps, the most attractive of all on the programme of the Section. It was a short paper by Mr. Parsons, with details of the fast cross Channel and Atlantic liners which he proposes should be driven by his steam turbines. Models of the proposed vessels were shown, and a working model of a set of steam turbines to show how simple it was to run astern.

Considering how frequently the wildest statements are made as to the possible speed of mail steamers and smaller fast passenger boats, it is noteworthy that Mr. Parsons proposes quite moderate speeds in his liners and cross-Channel steamers. This paper was made more interesting from the figures which the President had given, in his address to the Section, on the question of the relation of power to speed and displacement.

The President had shown conclusively how impossible it was to apply results deduced from small vessels to large vessels; and his calculations as to the enormous power required to drive one of the large vessels at high speeds show that we have little hope of obtaining such speeds with present conditions.

Mr. Parsons in his paper fixed the speed of his cross-Channel boat at thirty knots, and although the boat is only to have a 1000 tons displacement, it will require 18,000 horse-power to maintain that speed. He did indeed hint at an express-Channel steamer which should attain a speed of forty knots, but only at the expenditure of 50,000 horse-power: figures which are likely to damp the enthusiasm of any ship-owner or ship-builder. His Atlantic liner was to have a displacement of 18,000 tons and a speed of twenty-six knots, with an indicated horse-power of 38,000.

The paper which followed Mr. Parsons' was an extremely interesting and valuable one by Mr. Mark Robinson, on the Niclausse water-tube boiler. It came as a natural corollary to Mr. Parsons' paper, because Mr. Parsons had stated in his communication that his proposed steamers would be fitted with the water-tube type of boilers. The interest which has been aroused, and the controversy which has arisen over the introduction of water-tube boilers into the Royal Navy also made this paper one of considerable importance. The author only described fully the particular type of boiler with which he was most familiar, namely, the Niclausse; but the general conclusions and the general results apply equally to all boilers of this type.

Mr. Robinson pointed out in his paper that the Niclausse boiler as now made in this country, or rather as it will be constructed in this country when the plans now being made are completed, is very different from the Niclausse boiler which was fitted into one of the ships of the navy some years ago.

For reasons which are quite satisfactory the Admiralty have not yet been able to satisfactorily test these Niclausse boilers; and now in view of the great changes in the mechanical details of this type of water-tube boiler, interest in the results of their tests will be more or less discounted.

There is no doubt that this boiler will be one of the most satisfactory in its mechanical details of all the water-tube type, and will have a great future, both for sea-going purposes and on land as well.

One set of figures given by the author to show the advantage of the extremely short time required for removing and replacing a tube or tubes is worth quoting. In one instance the boilers were blown down, three tubes removed and replaced by others, and pressure got up again in thirty-five minutes from the time the operation started.

The concluding paper on Friday was one by Captain Lloyd, describing a method which has been developed at Elswick for discharging torpedoes below water from the broadside of a ship when steaming at a high speed. The problem, a most difficult one in all its mechanical details, has been successfully surmounted, and a considerable number of these submerged tubes have been already fitted, and a large number are in the process of fitting at the present time. The paper was, of course, a highly technical one; but the admirable diagrams which had been prepared rendered it easy to follow the working of the mechanism from the firing of the cordite charge to the exit of the torpedo from the tube.

Saturday was fixed by the authorities as the day upon which the French Association would pay their official visit to the British Association, and the paper which was read before the Section, reinforced by a considerable number of French engineers, was one by a distinguished French engineer, M. Alby, describing the construction and erection of the Alexander III. bridge over the Seine in Paris. This bridge forms part of the Great Exhibition of 1900, and is situated on the line of the Great Avenue which will connect the Champs Elysée with the Esplanade des Invalides. Æsthetical considerations, therefore, have played a most important part in the design which has been adopted. A low-arch form of bridge was the only acceptable one, and the great horizontal thrust produced by such a type of arch has given the engineer a very anxious task in the design of his abutments. A full description of the bridge was given, and of the costly but necessary temporary structure or travelling bridge, as the author termed it, by means of which the erection of the bridge proper has been carried out. During next year engineers will have an opportunity, when visiting the Exhibition, of admiring the beauty and harmony of the design, and the skill with which the great difficulties met with have been overcome.

Monday, as usual the electric day, was not in this instance productive of anything very striking. Perhaps the most interesting communication was one by Mr. Cowper-Coles on some recent applications of electro-metallurgy to mechanical engineering. The author described a very beautiful process for the electrolytic manufacture of projectors for search lights for naval and military operations. A projector made by this process was exhibited to the meeting, and figures were given to show that the fine coating of palladium used protects the silver-faced projector from any injury owing to the intense heat of the arc-light, the pure silver face being found to tarnish very rapidly in consequence of the intensity of the heat.

Some brief notes by Mr. A. Siemens on electrical machinery on board ship were interesting because they gave the President the opportunity of refuting the common notion that we are behindhand in the application of electricity to ammunition hoists and other purposes in our navy. The President pointed out that in matters of this kind the opinions and the wishes of those who have to work the appliances must be taken into account.

The concluding day was devoted to several papers of extreme interest. The business was begun with the consideration of a paper by Mr. Thornycroft on recent experiences with steam on common roads. After dealing with the impediment to progress due to the Locomotives on Highways Act of 1896, and making suggestions as to the steps which should be taken to remove these obstacles in future legislation, the author gave an extremely valuable *résumé* of his own work in this field of mechanical science. He described the different types he has built since 1896, and the chief changes in the mechanical details which experience has convinced him to be necessary. He has built vehicles both for heavy goods traffic and for passenger traffic, and has adopted a method of chainless transmission in his most recent type. The author in conclusion pointed out that, after all, in motor work a good deal depended upon the care and intelligence of the driver employed.

A paper by Mr. Edward Case, who, we regret to say, died only a few days after the paper had been read, descriptive of the Dymchurch sea-wall and the reclamation of the Romney marshes, was next taken. These reclamation works are of great antiquity; in modern times the erection of high groynes for the protection of the wall brought about that which they were expected to prevent, namely, the undermining of the wall. Mr. Case decided, when he took over control in 1890, to adopt an entirely different system, and since 1894 a number of low groynes have been run out; the result of which has been to raise the level of the fore-shore as much as 8 feet at the east end of the wall. These groynes have been constructed in such a way that they can be gradually raised as the level of the beach gets higher, at a very trivial expense and with very little difficulty.

The Section meeting was, as has been stated before, an extremely successful one: the quality of the papers being high, the discussions good, and the attendance throughout thoroughly satisfactory. There can be no doubt that a great deal of this was due to the energy and the interest taken by the President in the work of the proceedings. It is too often forgotten by Presidents of Sections that the success of any particular Section is almost entirely in the hands of its President.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The 204th meeting of the Junior Scientific Club was held in the University Museum on Friday, October 20. Mr. Hartley (Balliol) read an interesting paper on the history of the discovery of the law of isomorphism.—Owing to the length of important private business Mr. Gibson (Ch. Ch.) was unable to read his paper on the retention of food by plant soils, as announced.—The following are the officers for the ensuing term:—J. T. Mance (Balliol), pres. H. E. Stapleton (St. John's), chem. sec. C. H. Barber (non-coll.), biol. sec. F. W. A. Fleischmann (Magd.), treasurer. F. W. Charlton (Merton), editor.

The examiners have notified to the Vice-Chancellor that they recommend for election to the Burdett Coutts scholarship, which is of the annual value of about 115*l*. and tenable for two years, Mr. J. B. Scrivenor, Commoner of Hertford College. They also recommend that Rev. E. C. Spicer, Commoner of New College, be appointed an extra scholar, to retain his scholarship for one year.

CAMBRIDGE.—St. John's College has once more shown its appreciation of scientific merit by electing to fellowships Mr. J. J. Lister, University Demonstrator of Comparative Anatomy, and Mr. A. C. Seward, University Lecturer in Botany. Mr. Lister, who has done important work on the *Foraminifera* and other groups, is a nephew of the President of the Royal Society, and son of Mr. Arthur Lister, who was last year elected a Fellow of the Society. Mr. Seward is a Fellow of the Royal and Geological Societies, and has attained a high position as an authority on fossil plants. The first volume of his treatise on this subject was reviewed in NATURE (December 15, 1898). He has held the Harkness Studentship in Palæontology, and gained the Sedgwick Geological Prize in 1892. Both gentlemen are Masters of Arts of the College of some years' standing, and have been elected out of the ordinary course.

Mr. J. L. Tuckett, Fellow of Trinity College, has been appointed an additional Demonstrator of Physiology by Sir M. Foster.

Prof. G. Sims Woodhead has been elected to a Fellowship at Trinity Hall.

THE details of the reorganisation of the Education Department and the transference of its duties to the new Board of Education are under consideration by a departmental committee; and the committee of the City and Guilds of London Institute have signified their willingness to give any help which may be needed to secure the proper recognition of technological teaching in the arrangements about to be made. Reference to this matter is made in the report of the examinations department of the Institute issued a few days ago. It is remarked that, having regard to the Institute's close connection with technical teaching in all parts of the country, no organisation of education can meet existing requirements which does not take into consideration the educational work now under the immediate direction of the Institute. The report further states that the committee fully recognise how desirable it is to avoid, as far as possible, any overlapping in the organisation of the classes and examinations directed respectively by the Science and Art Department and by the Institute; and they are of opinion that, with the view to the due encouragement of practical instruction in the technology of the different trades in which artizans are employed, the teaching of technology should be placed on the same basis, with respect to State aid, as that of science or art.

MR. A. E. BRISCOE, the principal of the West Ham Municipal Institute, sends a few particulars of the loss caused by the disastrous fire which occurred a few days ago. The whole of the upper floor of the building, including the chemical, art and women's departments, the engineering and physical lecture theatres, the drawing office and the engineering laboratories have been completely gutted. The chemical and art departments are the greatest sufferers, but there is not much to choose between them and what has happened to the others. The electrical and physical laboratories were flooded by the water, and a great many expensive instruments have been damaged by water; but the galvanometers and some of the other expensive things were on shelves covered by dust-covers, so that they have escaped damage. The expensive machinery in the engine and dynamo laboratories and in the engineer's workshop has not suffered by fire, but, of course, tons of water have fallen upon it, and a very great amount of damage has been done. The institute was covered by insurance to the extent of 47,000*l*., and it is believed the total damage will not reach this amount. Of course, nothing can compensate for the large amount of work that has been done by the staff in the equipment of the institute, and will now have to be done all over again. Though the borough is not a rich one, it is satisfactory to know that the institute will be rebuilt and probably enlarged, as the classes were already too great for the accommodation. The fire commenced in the advanced chemical laboratory, but the origin is absolutely unknown. The building had not been used for thirty-six hours prior to the outbreak.

SCIENTIFIC SERIALS.

Symons's Monthly Meteorological Magazine, October.—Meteorological extremes. II. Temperature. Mr. Symons has collected a large amount of useful information upon this subject from all trustworthy sources. For yearly mean temperatures preference is naturally given to Dr. Buchan's isothermic charts published in the *Challenger* volume, "The Circulation of the Atmosphere." The highest yearly isotherms are 85°, and these occur only in three localities, the largest covering a portion of Central Africa, bounded on the north by latitude 18° N. Two smaller areas exist, one in Central India and the other in the northern portion of South Australia, respectively in latitude 15° N. and 15° S. The absolute range of the shade temperature in the northern hemisphere, and probably in the world, is 217°·8, depending on the absolute maximum of 127°·4 in Algeria, July 17, 1879, and the absolute minimum of −90°·4 at Verchoiansk, Siberia, January, 15, 1885. The hottest region is on the south-western coast of Persia, where the thermometer has been known not to fall lower than 100°, night or day, for orty consecutive days during July and August, and often to reach 128° in the afternoon. Among the highest shade temperatures we may mention one at night during the Italian occupation of Massowah, when the thermometer is said to have recorded 122°. Temperatures above 120° are occasionally met with in India; 121°·5 was recorded at Dera-Ishmail-Khan (lat. 32° N.) in 1882, and 126°·0 at Bhag (lat. 29° N.) in 1859. At Wilcannia on the Darling River, New South Wales, shade temperatures varying from 107° to 129° were recorded on each day from January 1 to 24 in 1896. Among the low temperatures (in addition to the extremes mentioned above) we may quote -63°·1 at Poplar River, North America, in January 1885. During the intense frost in Scotland on December 4, 1879, -16° was reported from Kelso and -23° from Blackadder, in Berwickshire. The extremes in or near London for 104 years were 97°·1 in July 1881, and 4° in December 1796 and January 1841.

THE *Journal of the Royal Microscopical Society* for October contains a short paper (with plate) by Mr. James Yate Johnson on some sponges belonging to the Clionidæ obtained at Madeira, in which three new genera are established, named *Acca*, *Nisella* and *Scantilla*. In the section on microscopy is a description of an old compass microscope taken from a German work on the microscope by Martin Frobenius Ledermüller (1763), called Russwurm's "Universal Microscope," which appears to have been a combination of compass and tube microscope in an unusual number of forms; also a description of "Adams' Compendious Pocket Microscope" (1771), which more nearly conforms to the microscopes of the present day than any of those which preceded it. In the section on technique several new pigments are described, also two new methods for orienting small objects.

Bollettino della Società Sismologica Italiana, vol. v., Nos. 2, 3. 1899-1900.—Vertical component microseismograph, description and results, by G. Vicentini and G. Pacher. A reprint of a paper already noticed in NATURE —Supplementary considerations with regard to the Umbria-Marches earthquake of December 18, 1897, by A. Issel.—The earthquake in the Parma-Reggio district of the Appennines during the night of March 4-5, 1898, by C. Agamennone. The shock was felt over an acre of about 70,000 sq. km., and was also recorded by horizontal pendulums at Strassburg and Shide; the velocity of the earth-waves will be considered in another paper.—The Hereford earthquake of December 17, 1896, by C. Davison. A summary (in English) of the writer's report on this earthquake.—Notices of the earthquakes recorded in Italy, February 5 to April 23, 1898; the most important being those of Asia Minor on February 5, Cividade (Udine) on February 20 and April 12, Reggio and Parma on March 4, Ferrara on March 9, and distant earthquakes on February 18 and April 15 and 23.

SOCIETIES AND ACADEMIES.

Physical Society, October 27.—Prof. W. E. Ayrton, F.R.S., Vice-President, in the chair.—Dr. S. W. Richardson read a paper on the magnetic properties of the alloys of iron and aluminium. Observations were made upon four alloys containing respectively 3·64, 5·44, 9·89 and 18·47 per cent. of aluminium. The alloys were used in the form of anchor rings, and were wound with primary and secondary coils separated by asbestos paper. The temperatures used ranged from -83° C. to 900° C. The low temperatures were produced by the rapid evaporation of ether surrounded either by ice and salt or by carbon dioxide snow. The high temperatures were obtained either electrically or by gas muffles. In both cases the actual temperatures were deduced from the resistance of the secondary, which was made of platinum wire and wound next the metal. The author employed Maxwell's null method of measuring mutual induction, increasing the sensitiveness by the introduction of a secohmmeter making about three revolutions per second. In order to test the accuracy of the method some of the experiments were repeated with a ballistic galvanometer in the ordinary way, and the agreement obtained between the results in the two cases was well within the limits of experimental error. The chief conclusions to be drawn from the experiments may be summed up as follows: (1) The alloys behave magnetically as though they consisted of two distinct media superposed. (2) The general roundness of the curves and their lack of abruptness near the critical point seems to indicate that the alloys are heterogeneous in structure. (3) The permeability decreases with rise of temperature near the critical point until a minimum value is reached, when further rise of temperature produces very slight diminution, if any, in the permeability. (4) The experiments suggest that the maximum value of the permeability for an alloy containing 10 per cent. of aluminium is reached at about -90° C. (5) An alloy containing 18·47 per cent. of aluminium has a critical point at about 25° C., and gives no indication of temperature hysteresis. This alloy probably has a maximum permeability much below -90° C. The author has found that at high temperatures there is a second maximum on the induction curve. This maximum becomes less and less noticeable as the field is increased.—The Secretary read a note from Prof. Barrett on the electric and magnetic properties of aluminium and other steels. The first part of the note dealt with the electrical conductivity of various alloys, and discussed the effect of composition and annealing upon the value of the conductivity. The second part of the note referred to magnetic effects. The most remarkable effect produced by aluminium on iron is the reduction of the hysteresis loss. The permeability of nickel steels is shown to be very much influenced by annealing. It is found that the addition of a small quantity of tungsten to iron hardly affects the maximum induction, yet increases the retentivity and coercive force. The experiments show that the best steel for making permanent magnets is one containing 7½ per cent. of tungsten. The magnetometric method was employed throughout. Prof. S. P. Thompson drew attention to the wide range of temperature over which the author had conducted his experiments, and also to the small number of alloys used. He said a very much finer connection between the properties could be obtained from the examination of more alloys, and expressed his interest in the existence of the second maximum on the induction curve. He would like to know how the percentage composition of the alloys had been determined. Turning to Prof. Barrett's note, Prof. Thompson referred to the difference in the breadths of the hysteresis curves for aluminium and chromium alloys. Mr. Appleyard asked for information upon the permanence of the curves. Dr. Richardson, in replying, said the compositions were determined by analyses made after the experiments had been performed. It was proposed to carry on the research upon a series of aluminium alloys which he had obtained. The Chairman expressed his special interest in the agreement which the author had obtained between the ballistic method and the null method of Maxwell increased in sensitiveness by the secohmmeter.—Mr. Addenbrooke exhibited a model illustrating a number of the actions in the flow of an electric current. The model consisted of a spiral of steel wire in the form of a closed circuit. Inside the spiral was placed a wire which was supposed to be carrying the current, and which directed the motion of the spiral. A rotational movement given to one part of the spiral was transmitted by the wire, and produced a rotational movement at another part of the spiral. The resiliency of the spring represents capacity, and the torque electromotive force. Self-induction can be represented by weighting the spring. Prof. Everett expressed his interest in the way that the correspondence between the propagation and rotation agreed with that between the direction of a current and the direction of the magnetic force. Prof. S. P. Thompson agreed that many analogies could be worked out by the model, but gave one or two examples to show that erroneous conclusions might be drawn by pushing the analogy too far.—Mr. W. Watson repeated some experiments with the Wehnelt interrupter devised by Prof. Lecher. The experiments showed in a clear and striking manner the fact that subsequent sparks tend to pass through the portion of air heated by the first one. In the first experiments motion of the heated air was caused by differences in density, and in the later experiments by allowing the sparks to take place in a strong electromagnetic field. The continuous rotation of the spark in a given field proved the unidirectional nature of the discharge. In reply to Mr. Blakesley, Mr. Watson said he used the word "ionised" in his explanations to express simply the fact that the air had been rendered a conductor by the passage of the spark. The Chairman referred to one of the first experiments performed. In this experiment the electrodes consisted of two copper wires in a vertical plane, slightly inclined to one another and nearest together at their lowest points. On switching on the current the spark passed between the lowest points; but as the ionised air ascended so did the most conducting path, and consequently the spark worked its way to the top of the electrodes. Here the heated air passed away and the spark returned to the lowest point to rise again. The Chairman thought that these effects might be due to the magnetic forces produced by the circuit itself. That similar effects in the arc light were due to this cause had been proved many years ago. Mr. Watson repeated some of the experiments under new conditions, and proved that the explanation of the phenomena was not to be found in the tendency of the circuit to enlarge itself owing to magnetic forces. Mr. Boys pointed out that the relation of the heating effect to the current, which was small in the arc light, was very large in the case of the spark discharges used, and therefore the movement of the spark in the latter case was practically determined by the heating effect in consequence of the relatively small importance of the electromagnetic effect. Prof. S. P. Thompson remarked that similar effects could be produced by an alternating current working an ordinary induction coil. —The Society then adjourned until November 10, when the meeting will be held in the Central Technical Institute.

PARIS.

Academy of Sciences, October 23.—M. van Tieghem in the chair.—On the simultaneous occurrence of phenomena of oxidation and hydration at the expense of organic substances under the influence of free oxygen and light, by M. Berthelot. Experiments were carried out on the slow oxidation of ether in presence of water and air, or of hydrogen peroxide. Practically no oxidation of moist ether takes place in the dark, either with air or hydrogen peroxide. After five months' exposure to light in a sealed tube, the air remaining over the ether contained no trace of free oxygen, but some aldehyde, acetic acid, and alcohol were found in the ether. A little methane is formed at the same time. Two chemical reactions are thus shown to go on together, a hydration and an oxidation. The author considers that similar reactions go on in nature, such substances as the sugars and carbohydrates, glycerides, &c., undergoing simultaneous hydration and oxidation.—Equilibrium of a vessel carrying liquid, by M. Appell. The author has shown in a previous paper on the same subject that the determination of the positions of equilibrium of a vessel with a liquid cargo may be reduced to the determination of the smallest value of the distance between two parallel planes tangential to two given surfaces. The problem is now simplified to finding the shortest distance of a fixed point to a tangent plane to one surface.—Observations on a note by M. Blondel, relating to the reaction of induction in alternators, by M. A. Potier.—On certain remarkable surfaces of the fourth order, by M. G. Humbert.—On the determination of the coefficient of solubility of liquids, by MM. A. Aignan and E. Dugas. In a previous paper by the authors it is shown how to determine the coefficients of reciprocal solubility of two non-miscible liquids when no contraction takes place. In the present paper, expressions are developed in which this restriction is removed, and the results are applied to experiments on mixtures of aniline and water, and amyl alcohol and water.—On merogonic impregnation and its results, by M. Yves Delage. The results published by the author a year ago showing the possibility of producing an embryo from a portion of an egg not containing a nucleus have now been extended. The fertilisation of non-nucleated ovular cytoplasm is not limited to the echinoderms. It is found in some molluscs, and in the annelid *Lanice conchylega*. Since it can no longer be looked upon as a biological curiosity, but is a process which may be generalised, the author proposes to give it the name of merogony.—The affinities and the property of absorption or arrest of vascular endothelium, by M. Henri Stassano. It is shown that it is the affinity of the vascular endothelium for mercury which is the cause of the predominance of this poison in the organs containing the most blood. This endothelium also appears to act in the same way with other poisons, such as strychnine and curare.—Death by the electric discharge, by MM. J. L. Prevost and F. Battelli. From a series of experiments on dogs, rabbits and guinea-pigs, the authors conclude that the fatal effects of the electric shock are proportional to the energy of the discharge, and are not proportional to the quantity of electricity passing.—The grafting of some monocotyledons upon themselves, by M. Lucien Daniel. After many unsuccessful attempts, it has been found possible to graft a part of a monocotyledon (Vanilla and *Philodendron*) upon itself. The success depends largely upon the extent of the surfaces in contact.—*La graisse*, a bacterial disease of the haricot, by M. Delacroix. The disease is probably identical with that recently described by M. E. F. Smith as affecting the haricot in the United States, and the bacillus from which is named *Bacillus phaseoli*. No curative treatment of the living plant would appear to be possible.—Observations relating to the deposit of certain calcareous travertins, by M. Stanislaus Meunier.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 2.

LINNEAN SOCIETY, at 8.—On the Proliferous State of the Awn of Nepal Barley: Rev. Prof. Henslow.—On the Hyobranchial Skeleton and Larynx of the New Aglossal Toad, *Hymenochirus Boettgeri*: Dr. W. G. Ridewood.—On the Eye-spot and Cilium in *Euglena viridis*: Harold Wager.

CHEMICAL SOCIETY, at 8.—The Theory of Saponification: J. Lewkowitsch. —The Action of Dilute Nitric Acid on Oleic and Elaidic Acids: F. G. Edmed.—Tetrazoline: Siegfried Ruhemann and H. E. Stapleton.—On Ethylic Dibromobutanetetracarboxylate and the Synthesis of Tetrahydrofurfuran-αα′-dicarboxylic Acid: Dr. Bevan Lean.—(1) Camphoroxime. Part III. Behaviour of Camphoroxime towards Potassium Hypobromite; (2) Optical Influence of an Unsaturated Linkage on certain Derivatives of Bornylamine: Dr. M. O. Forster.

CAMERA CLUB, at 8.15.—Scenery in the Canary Islands: T. C. Porter.

TUESDAY, NOVEMBER 7.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Address by the President, Sir Douglas Fox, and presentation of Prizes.

ANTHROPOLOGICAL INSTITUTE, at 8.30.—Notes on the Ethnology of Tribes met with during progress of the Juba Expedition of 1897–99: Lieut.-Colonel J. R. L. Macdonald, R.E.

THURSDAY, NOVEMBER 9.

MATHEMATICAL SOCIETY, at 8.—Certain Correspondences between Spaces of n Dimensions: Dr. E. O. Lovett.—On the Form of Lines of Force near a Point of Equilibrium; The Reduction of Conics and Quadrics to their Principal Axes by the Weierstrassian Method of reducing Quadratic Forms; and on the Reduction of a Linear Substitution to a Canonical Form; with some Applications to Linear Differential Equations and Quadratic Forms: T. J. I. Bromwich.—On Ampère's Equation $Rr+2Ss+Tt+U(rt-S^2)=V$: Prof. A. C. Dixon.—The Abstract Group isomorphic with the Symmetric Group on k Letters: Dr. L. E. Dickson.

FRIDAY, NOVEMBER 10.

ROYAL ASTRONOMICAL SOCIETY, at 8.

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