THURSDAY, JULY 19, 1888.

THE CHOICE OF A CHEMIST TO THE NAVY.

SIR HENRY ROSCOE'S watchful regard of the true interests of science was evidenced by his recent question in the House to the First Lord of the Admiralty, whether, in consequence of the resignation of Dr. Debus of the Professorship of Chemistry in the Royal Naval School at Greenwich, it was proposed to reduce the status of this post to a lectureship; and if so, whether he would take into consideration the inexpediency of this step being taken, in view of the importance to naval officers of a knowledge of this science, and of the necessity that in the Government Naval School the post in question should be filled by a gentleman of the highest possible scientific position and attainments.

Lord G. Hamilton is reported to have replied that the resignation of Dr. Debus, Professor of Chemistry at the Royal Naval College, had only just been received by the Admiralty, and therefore it would be premature to make any statement as to the manner in which it may be thought desirable to fill the vacancy so caused. The policy of the Admiralty was always to inquire into the circumstances of any appointment of this kind that may fall vacant, with the view of adjusting the salary to the requirements of the day.

It must be obvious that this statement savours most strongly of officialism, and that it affords no information whatever with regard to the views and intentions of the Admiralty. We have already clearly indicated what are the requirements of the day, and Sir Henry Roscoe has given emphasis to our views; but it is more than probable that unless attention be again directed to the importance of the issues involved in the appointment of a chemist to the Navy the course of action indicated in our previous article as likely to be followed will inevitably be adopted.

We therefore without hesitation again urge that in a case of this kind only one course can be adopted with safety by the Admiralty, if the interests of the nation are to be considered—that course is to engage the services of the best man available. No candidate's claims should be considered unless it can be shown that he is a trained chemist, and has been actively engaged in the pursuit of new knowledge; and unless it appear probable that he is enthusiastic and single-minded enough to continue to interest himself in research work and to lead his senior pupils to engage in research. We are fully aware that in imposing this standard we are demanding higher qualifications than many may consider necessary; that some may even think that nothing more is required at Greenwich than one who will teach young midshipmen the elements of chemistry and simple analysis fairly well; but to this we demur most emphatically, believing it to be incontestable that the science of chemistry may minister directly and indirectly in so many ways to the wants of our Navy that it is essential to give it the highest possible footing in the course of study at a naval college.

In the recently published life of W. E. Forster, a fragment of conversation at a dinner party preserved by Mrs. Forster is recorded which will be aptly quoted here. "Mr. —— said that —— was always going about asking people what was the ideal towards which they were working, and there was a laugh at the notion. But my husband did not join in it, saying that, for his part, if he was not constantly thinking of the ideal which he was working up to, he should not be able to get on at all." We venture to think that the infertility of British chemists and the inferior position which chemistry holds in this country, especially at our two great universities, as well as our failure to excel in those industries in which chemistry plays an important part, are due to the absence of an ideal among our chemists generally in any way approaching to that which has long obtained in Germany, where no higher grade appointment can be bestowed except on a man who is master of his subject, and not a past-master even but an active worker; and it is the absence of any such ideal which in cases like the present renders it possible for the authorities to entertain the suggestion of reducing the status of the post at Greenwich.

We believe that a master chemist is required at Greenwich for a variety of reasons. Firstly, as a matter of national honour; secondly, because, as we have already said, the subject must be taught technically, *i.e.* with direct reference to the knowledge and requirements of the students; thirdly, because the students are not only young beginners, but are of all ages, including many men of ripe experience, and it is scarcely necessary to remark that no one who is not a thorough chemist can possibly gain the sympathies of this latter class; and, lastly, because no one who is not himself actively engaged in research will remain *au courant* with the progress of knowledge, and will be able to select and incorporate into his teaching important new facts, thus avoiding the otherwise inevitable tendency to teach in a stereotyped and bookish fashion from year to year.

The proper man being found, he should be told at the outset that it is expected that when engaged in investigation he will devote his attention primarily to problems of importance in the Navy; a short intercourse with men versed in naval affairs and requirements would soon furnish an active-minded chemist with more than sufficient subject-matter meriting attentive study. It is more than probable that if a good example were set, and a spirit of enthusiasm kindled among the students, officers who had been led to take a real interest in chemistry would be willing, in the intervals of enforced inactivity when they were not on service, to devote themselves to research; and if but moderate encouragement were given to such men, we can conceive that Greenwich at no distant date might become an important school of naval research.

Unfortunately it is only too obvious that the public are slow to heed the repeated warnings of experts that our competitors in commerce are outrunning us largely because of their readiness to avail themselves of the aid which science can afford to industry. The evidence that foreign Governments are more anxious than is ours to make every possible use of science in the service of the Army and Navy is also growing daily; but we are confident that in the present instance the danger of the retrograde action which appears to have been contemplated having been pointed out, the naval authorities will not allow themselves to be guided by shortsighted advisers, and will no longer countenance any change which does not enhance their opportunities of receiving aid from so all-important a branch of science as chemistry.

NEW WORKS ON LEPIDOPTERA.

South African Butterflies: a Monograph of the Extra-Tropical Species. By Rowland Trimen, F.R.S., &c., assisted by James Henry Bowker, F.Z.S. Vols. I. and II. Royal 8vo. (London: Trübner and Co., 1887.)

Descriptions of New Indian Lepidopterous Insects from the Collection of the late Mr. W. S. Atkinson, M.A. Part III. Heterocera (continued). By Frederick Moore, F.L.S., &c. 4to. (Calcutta: Published by the Asiatic Society of Bengal, 1888.)

MORE than twenty-one years have elapsed since Mr. Trimen finished the publication of his "Rhopalocera Africæ Australis." During the whole of this time he has kept the subject of South African butterflies steadily in view, and the number of additional species discovered in South Africa is so large that he has chosen a new title for his book rather than call it a second edition of the old one.

Between 1866 and the present time the number of species of butterflies known to inhabit South Africa has swollen from 222 to 380, and instead of a small octavo volume we have now before us two out of three royal octavo volumes of goodly dimensions. This progress in the study of a favourite group of insects in South Africa probably represents a similar progress in the knowledge of the butterflies of the world, for nearly everywhere it has been increased by rapid strides.

Mr. Trimen has had the advantage of living in the country the butterflies of which he describes, and he has been in close correspondence with numerous enthusiastic helpers, foremost amongst whom is Colonel J. H. Bowker, whose name appears on the title-page as Mr. Trimen's coadjutor.

The earlier chapters of the work are devoted to general subjects relating to insects and leading up to the special subject in view. In all this portion Mr. Trimen has exercised admirable judgment, giving the leading points in concise but clear language. The classification adopted is that of Mr. H. W. Bates, which has now stood the test of many years' practical working, hardly any important alteration having been made in its main features since it was published. Still, much remains to be done before some of the great families, such as the Lycænidæ and Hesperidæ, and sub-families, such as Satyrinæ and Nymphalinæ, can be reduced to order.

As is well known, the front pair of legs in the imago provides one of the most important characters for determining the families of butterflies. Their examination affords a most interesting study. Owing to improved methods of preparing these limbs, whereby their scaly clothing is either destroyed or rendered invisible, they can be conveniently arranged for microscopic examination. The full extent to which they are atrophied is thus clearly revealed. The front legs of the males in the members of some families have their tarsal joints either more or less fused together or reduced to a single atrophied joint; but the variation in the extent to which this takes place is great. It sometimes also happens that when a number of individuals are examined, one will be found in which rudimentary spurs appear, and even unsymmetrically and attached to one tarsus only and not the other of the same insect. In some cases recently examined, males in the Erycinidæ have been found with the front legs furnished with the full complement of joints and with claws. The like occurs in the Lycænidæ both in America and in South Africa. Such cases, however, are exceptional, and though they break down to some extent the universal application of these characters to the discrimination of families, discrepancies are only to be expected, and the wonder is there are so few of them. Mr. Trimen appears to have studied this part of his subject with care, but a closer examination than is usually made will repay the labour of arranging the preparations. Though the variation in the relative lengths of the femur, tibia, and tarsus have been compared, the coxa has seldom been taken into consideration. Yet it, too, furnishes useful points for distinguishing forms, and in the case of the Erycinidæ the prolongation of this joint in the male front leg beyond its junction with the trochanter is diagnostic of the family. Mr. Trimen has not made any use in his classification of the varied structures presented by the secondary sexual characters of the terminal segments of the body; but there can be little doubt that, as improved methods of preparation are discovered, these characters will be found very useful in determining the relationship of species if not of genera.

The limits of the fauna treated of, as the title of the book states, extend from the Tropic of Capricorn southwards to the Cape of Good Hope. This district forms a sub-region of the great African or Ethiopian region. Its distinguishing characteristics are mainly negative, only six out of the sixty-nine genera not being found elsewhere, though 195 out of 380 of the species are peculiar. Whether the northern limit of this section of the African fauna really lies along the tropic remains to be seen, as our knowledge of the butterfly fauna north of this line is very meagre: of the interior we know nothing, and of the coasts not much. Regarding the internal distribution of the species, it would appear that the western and central portions, as well as that in the neighbourhood of the Cape, are poor in species. During a residence of over twenty-five years, Mr. Trimen has succeeded in capturing only forty-seven species within a radius of twelve miles from Cape Town. In the eastern districts the fauna is richer: Natal produces 206 species, and in the neighbourhood of Delagoa Bay many additional species occur. Each species is very fully described in this work, and many useful notes are added whereby the allied forms may be discriminated. Their history and range are also given with great precision. The larvæ and pupæ of many species are described, and this feature is a very acceptable addition, as most works on exotic Lepidoptera are silent on the subject.

The portion of the introduction that will be read with the greatest interest is that which relates to protection, resemblances, mimicry, &c. (pp. 32-40). A concise summary of the best work on this subject is given; and the instances furnished by the African butterfly fauna are described more in detail. Some years ago Mr. Trimen brought forward some very interesting cases of mimetic resemblances in butterflies, the most important being that in which *Papilio merope* is involved. He was able to prove that, wherever it is found, the females of this species take the pattern of a *Danais*, and though the males hardly vary over a very wide area, the female varies with the *Danais* in each district except in

Madagascar and Abyssinia, where females and males are alike.

The plates, on which a selection of the less known species are depicted, are chromolithographs, and are rather uneven in quality, as is usually the case in drawings of butterflies by this process. Some of the figures are admirable, while others, such as the Lycænidæ, are not at all satisfactory. Notwithstanding this defect, we can safely say that Mr. Trimen's "South African Butterflies" is the best-planned and best-executed work of its kind that has yet appeared. It cannot fail to promote an accurate study of the Lepidoptera of the country of which it treats; and it may serve as a model for entomologists to follow when writing of the butterflies in other portions of the world.

Mr. F. Moore's book on new Indian Lepidoptera, the third and concluding part of which is before us, is a work of a very different character from Mr. Trimen's, and consists of descriptions of new species from the collection of the late Mr. W. S. Atkinson. Mr. Moore has long been engaged on work of this kind, and every year issues scores of descriptions of Lepidoptera, chiefly Heterocera, of India. His former position as Assistant Curator to the Indian Museum placed him in communication with a number of correspondents, who have helped him to gather together probably the most important collection of Indian Lepidoptera in existence. Without such a collection no work like the present could be undertaken. We confess, however, to a feeling of despair as to the future of the subject treated of when we glance at the descriptions before us. They are descriptions of the barest kind, scarcely relieved by a few comparisons, and with hardly a note to break the tedious monotony of the frequent repetition of the same characters over and over again. Whether future workers will be able to determine species by them without reference to the types is more than we can say, but we do not envy them the task of trying the experiment. And here we note with regret that the types of these species are not to be found in our National Collection, but in the possession of Dr. Staudinger, of Dresden, and some of them in Mr. Moore's own cabinets. This might have been otherwise had more interest been shown by our home authorities in the productions of our great dependency.

On the title-page of this part it is stated that members of the families Pyralidæ, Crambidæ, Geometridæ, Tortricidæ, Tineidæ are treated of, but in the body of the work new species are referred to no less than twenty-three other families of Heterocera. In the present state of the classification of Heterocera such an oversight is hardly to be wondered at. No serious attempt has been made for many years to place the classification of the moths on a sound and definite basis. The old systems are to a great extent obsolete, and the more recent attempts to modify them, by their halting and spasmodic character, have increased rather than lessened the confusion.

Mr. Moore has introduced a number of new generic names into this work, but he seldom gives any clue to the relationship of the proposed new genus. On p. 283 he commences descriptions of some "additional species" by introducing five new generic names for sections of the great genus *Papilio*. Whether this genus should be divided into many or left as a large aggregate of species is a disputed point, but we have no hesitation in condemning the plan here adopted of thrusting these names upon us in this piecemeal fashion. To anyone who will give the whole subject a careful examination and work out the diagnostic characters of the groups of this wonderful genus we are prepared to give a patient and respectful hearing; but to name sections here and there, with brief descriptions which are anything but diagnostic, is a practice to be deprecated.

Three coloured plates accompany this part, on which eighty-seven species are depicted. These are carefully drawn and nicely coloured, and form a substantial addition to the book.

We note that the first sheet of this part bears the date of September 5, 1887, but the title-page that of 1888. The meaning of this is not obvious, as the former is valueless in face of the later date of the title-page and wrapper.

FACTORS IN LIFE.

Factors in Life. By H. G. Seeley, F.R.S. "People's Library Series." (London: Society for Promoting Christian Knowledge, 1888.)

THE book before us is one of the useful series of household guide books, published by the Society for Promoting Christian Knowledge and intended to instruct the people in some of the more important laws of health. There are so many guide books on this subject at the present time that Prof. Seeley has, we feel sure, found it a difficulty of no slight kind to put before his readers the material he had in hand, so as to feel that he was supplying anything that by its novelty could be considered acceptable. Happily the enormous importance of his theme has come to his aid, and has enabled him to bring forth an essay which makes up in earnestness whatever it may, by very necessity, want in originality; for health is like truth—it can never be confirmed enough, nor have too many able expositors.

The factors in life treated of by our author are health, food, and education. Health he defines, very tersely, as "the condition of life in which the body produces more energy than is lost in performing our work"; and then he proceeds to indicate the various methods, habits, and practices by which it can be secured by the individual and by the community at large. With much prudence the Professor dwells on the obstacles that lie in the way of health from the expense that attends their application. He illustrates this uncommonly well in regard to cleanliness. "The difficulty," he says, "of securing the universal practice of the habit is chiefly a matter of expense. There are few pleasures more costly than perfect cleanliness, since it implies labour in every detail." Here, too, he enforces what all practical sanitarians have foreseen, that such labour can never be satisfactory unless the woman of the house, the wife, can direct and take part in it, "because servants can in no other way become of the same flesh and blood as their employers. Personal cleanliness to be of any value must extend to all members of a household. It is as important for the servants as for the mistress, for they are often exposed to greater chances of infection, and have greater capacity for diffusing disease. If the cook and the kitchen are not scrupulously clean, the health of the household suffer with every touch given to food, and many an obscure derangement of health which baffles medical skill is due to this poison of dirt." Touching the question of national cleanliness, we are very glad to find Prof. Seeley spotting the greatest of all political evils of a social kind—the evil of allowing a monopoly to companies for the supply of fresh water to the community. "The wisdom of the State," he affirms, "never permitted any greater obstacle to come between the people and their health than the monopoly of water companies who make water an article of trade;" from which saying we only dissent in regard to one word—the word wisdom, for which the truer word folly ought, we think, to be substituted.

Prof. Seeley takes a decisive view of the duties of the members of the profession of medicine, to whom he would apply the drastic reformation inaugurated by that heathen Chinee, who makes the doctor earn his fees not by treating the man that is sick, but by keeping the man that is whole always free from sickness. The doctor, according to this prescription, would keep up the health of the household by contract, through which plan there would be no necessity for sick-hospitals, sick-beds, or any other of the extensive and costly methods now in use for keeping up the cure of disease. The whole art of medicine would be an art of prevention; and cure, now the almost sole object of the highest skill in medicine, would be quite subordinate to prevention. But where then would poor medical science be landed? Every man would be his own general practitioner, every housewife would be a physician, every old woman who had gained most experience from observation of preventive measures would be a consulting physician, and there would be nothing to cure. Fie on you! learned, if not jealous, Professor, for suggesting such a heartless disintegration of the great and noble sciences of pathology and therapeutics. The next time we meet you we will not speak to you unless you publicly recant such brazen heresy, and repent in dust and ashes. Seriously, the idea of such a change is not far off, and indeed has, to some extent, commenced amongst the more advanced members of the educated community. It is an idea that will spread far and wide, and in half a century or so may be the fashion of the time.

On the topic of food our author is very explicit, and is strong in his recommendations to feeders generally that they should distinguish carefully between foods that are *bonâ fide* foods, and those which are merely stimulants. Tea and drinks of its class owe their popularity to their power of arresting waste or nervous exhaustion, and this constitutes their superiority over alcoholic drinks. Neither, perhaps, is food in the popular sense of the term. "Wine and its allies give a fillip to the nervous system, which enables exceptional work to be done at the price of increased nervous exhaustion, and draw a bill on the strength which must be met at a short date: while tea and its allies enable increased work to be done by making the dormant strength available, and discount, on favourable terms, the bills we hold on nervous energy." This is sound and plain teaching, told in a concise form, that deserves to be retold by all who have the advantage of learning from the volume before us.

We are glad to see that Prof. Seeley inclines calmly and judiciously to the advocacy of a more distinctive national leaning towards vegetable products as foods. He sees that the ease with which animal foods can be prepared for the table is greatly to the advantage of their popularity, until a better system of cookery is established throughout the land, in which vegetable foods shall play a more distinguished part than they have ever yet played in this country up to the present date. "The sum," he tells us, "that is annually spent on animal food in this country is more than £114,000,000, or upwards of a ninth of the national income; while the sum spent on bread, potatoes, and vegetables combined is £127,000,000. By a reformed diet it is probable that a substantial saving of about £30,000,000 a year might be made in the cost of nitrogenous food alone, without any serious change in national habits, and with advantage in every way."

Turning lastly to the essay on education as a factor in life, we find excellent rules for combining education with health, and both with good morals. "Education begins earliest in childhood, ends only in death, and survives death itself in its effects on after time." In fact, "Nature has appointed no period for education." These are some of the wise and prudent sayings which the author places before his readers, with many others on which we have not space to dwell. But it would not be just to conclude without directing attention to the *summum bonum* of educational efforts which, in his last pages, Prof. Seeley impresses on his countrymen. He deals here with the subject of education on its religious side. The religious feeling is, he contends, partly an inherited character of the race, and partly the product of education. But, unless it permeates and saturates life so that every act and endeavour of existence has a basis which unites them into one sustained movement onward towards higher things, he should not express what he conceives the religious side of the education of life should be. The sciences are the sisters of religion, in that they unfold something of the laws by which the universe is governed and by which the life of man is directed. "They are thus far the stepping-stones of faith. And those who have learned that health is the reward of moral discipline, that mental vigour may be augmented by the wise or moral use of food, and that education is the systematic exercise of moral responsibility in any or all the affairs of life, may find that in the practice and the pursuit of the truths of science they are conscious of a religious education which is a light to their feet." The words are true. The words are a true gospel—a gospel new and true and ever-extending; and we congratulate the religious Society which has had the courage to publish them, as heartily as we congratulate the author who has had the good sense and moral faith to send them forth for publication.

THE LANDSLIP AT ZUG.

Die Catastrophe von Zug, 5 Juli, 1887. (Zürich: Hofer und Burger, 1888.)

AN account of this catastrophe, written by Prof. Bonney, who visited the scene of ruin, has already appeared in the pages of NATURE (vol. xxxvi. p. 389). The present volume, compiled from official documents, gives a fuller history and more minute details of the results of the slip than were at that time accessible. It mainly consists of an elaborate report, written by Dr. A. Heim, the well-known Professor of Geology at Zürich, "Ober-ingenieur" R. Moser, and Dr. A. Burkli-Ziegler, to which are appended brief accounts of the incidents of the catastrophe, and of that which occurred in 1435, and lastly, a note on the disposal of the fund raised for the benefit of the sufferers. Plans and sections (extracted from the series which was attached to the above report) accompany the book, and indicate very clearly not only the amount of the mischief done, but also its cause, which, as already stated in these pages, is the existence of a deep deposit of silt beneath the superficial gravelly soil. The latter is but a very few feet thick, and suffices for the foundation of the less important buildings; the former constitutes the shelving bed of the lake to a depth of more than 100 feet. Borings made at various stations on the land, not far from the lake margin, have shown that this material remains incoherent to nearly the above depth, after which it becomes stronger. Hence there is always a danger of the underlying silt being squeezed outwards into and upon the bed of the lake, and the plans and sections furnished with the present volume show precisely how the accident occurred. There appear to have been some premonitory indications of the coming mishap, in addition to the subsidence in the new pier wall, which had already excited alarm. The inhabitants of certain houses, which afterwards fell, had observed sundry small displacements, which were especially shown by the jamming of doors and windows; cracking noises also had once or twice been heard. But the actual catastrophe was very sudden. About 3.20 p.m. the end of the quay wall, which had been completed up to a sort of little bastion, began to crack and sink. A quarter of an hour later came the first great slip, which caused the loss of seven lives. Except for some minor slips, there was then a pause for rather more than three hours, and then at 6.50 p.m. the second and greater slip occurred. A graphic account is given of the terror caused by this second catastrophe, which caused the loss of four more lives. A third, but comparatively unimportant, slip occurred at 10.15 p.m.

From the plan and sections it is evident that the second slip affected the larger area, both of the land and of the lake bed. Each slip forced the loose silt horizontally outwards, so as to form a delta-like deposit on the lake floor, thus diminishing the depth of the water sometimes by about 4 or 5 yards. At the first slip a triangular piece of ground, measuring about 80 yards along the shore, and some 40 yards to its apex inland, was destroyed, and the "delta" produced by this, which in outline resembles a rather stout pear, is about 250 yards across the wider part, and apparently extends to about 450 yards from the shore. By the second slip not only a much larger piece of the land (with a rudely oblong boundary) was removed, but the lake bed opposite to it, for a distance of 220 yards, appears to have slipped, so as to form a kind of broad trench, resulting in an interval of deeper water some 50 yards wide. The material thus removed was deposited over the deeper part of the lake bed, covering a space not quite so wide as that occupied by the former "delta," but much more than double the length, for its end is placed 1020 metres from the shore, at a depth of 44 metres.

These elaborate maps and sections, with the results of investigations (by means of borings) into the nature of the lake bed, the level of the ground water, &c., give a high value to this publication, which may be commended tothe notice of architects and engineers, as well as to those interested in the history of Switzerland.

OUR BOOK SHELF.

Turbans and Tails; or, Sketches in the Unromatic East. By Alfred J. Bamford. (London: Sampson Low, 1888.)

THE author of this book does not claim to have anything very new or striking to tell his readers. He has seen a good deal of India and China, and is content with reproducing, in a popular way, the impressions made upon him during his not very exciting sojourn in those countries. He has little to say about "the mild Hindu" or "the man of Han" that tends to make us think more highly of either. Mr. Bamford, like many English travellers, is apt to be impressed by the bad rather than by the good aspects of unfamiliar types of character; and some of his sweeping judgments would no doubt have been considerably modified if, in estimating the intellectual and moral qualities of Orientals, he had remembered more frequently and vividly than he has actually done, that thought and conduct in the East and West cannot always be fairly or wisely measured by the same standards. The book, however, has the merit of being written in a lively style, and the author's judgments, whether sound or unsound, invariably result from his own observation and reflection. Here is one of a good many suggestive anecdotes which brighten his pages: "Of what caste are you?" asked an Englishman of a native of India. "Oh," replied the native, "I'm a Christian—I take brandy shrab, and get drunk like you."

The Photographer's Note-book. By Sir David Salomons, Bart., M.A. (London: Marion and Co., 1888.)

BOTH amateur and professional photographers, and especially those who travel and take a great number of photographs per day, will find this little book very handy and useful, as it is of a very convenient size and contains enough space for inserting the particulars, such as number of stop, rapidity of shutter, remarks on the light, &c., of each of fifty-one dozen plates.

Formulæ for enlargement and depth of focus and rules for exposure are added, followed by a table, calculated by Messrs. Marion, of the correct quantities to be taken from 10 per cent. solutions to make up developers for all the best known plates. The book concludes with various tables, such as area enlarging, enlarging by linear dimensions, and equivalent focal lengths of lenses of different sizes and makers.

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.*]

"Cloud Electric Potential."

I DESIRE to draw the attention, more particularly of your electrical readers, to the following paragraph on p. 651 of the eighth edition (1884) of Deschanel's "Natural Philosophy," part iii., which appears distinctly at variance with the theory o thunderstorms as explained in Prof. Silvanus Thompson's "Elementary Lessons," and similar elementary treatises:—

"The coalescence of small drops to form large ones, though it increases the electrical density on the surfaces of the drops does not increase the total quantity of electricity, and *therefore cannot directly influence the observed potential*."

Surely this entirely omits the fact that the capacity of a sphere is equal to its radius, and thus in the case of eight equal spheres coalescing into one (which is taken by Prof. Thompson), not merely would the density be doubled, but the potential of the *same quantity* would be increased *four* times.

In the well-known case given by Prof. Tait for the formation of a raindrop the potential of the same quantity might be increased fifty million times.

The source of the energy which is the cause of the increased potential in this case, is probably the molecular force of cohesion released during the act of condensation and union, the cohesion and the electricity being oppositely placed, so that while the former is running down hill (as it were) the latter is obliged to run up; the top of the hill answering to the critical moment for disruptive discharge.

In view of these facts, it seems to me that if the above sentence is not altogether erroneous, it is certainly ambiguous, and liable to breed false notions in the mind of the unreflecting and too credulous student. E. DOUGLAS ARCHIBALD.

Transparency of the Atmosphere.

IT may be, I think, desirable to correct an error which has crept into all the accounts of the extraordinary transparency of the atmosphere observed here last week. It occurred on Sunday, the 8th, and not on Monday, the 9th inst. I can confirm the several details as to the objects visible to the unassisted eye. But in one respect this effect was surpassed on August 20, 1887, when the double flash of the Dunkirk light, distant from this place about forty-five miles, was visible for several hours. This light could not be seen here on the 8th inst.

Pavilion Hotel, Folkestone, July 16. J. PARNELL.

Preserving the Colour of Flowers.

IN response to the inquiry of "A. W.," perhaps you will allow me to say that many years ago I met with Mdlle. d'Angeville, the first lady to ascend Mont Blanc. She possessed the largest and best preserved collection of Alpine flowers I have ever seen, and she assured me she never used anything but cotton-wool in her press, changing it, of course, frequently. Her gentians, pedicularias, and other delicate plants were perfect in colour; and having tried her plan myself, although with less care, and therefore with less success, I still have Alpine flowers which have retained their colour for twenty years.

54 Doughty Street, July 17. A. W. BUCKLAND.

Distribution of Animals and Plants by Ocean Currents.

IN connection with Miss Buckland's letter on this subject it may be interesting to note that, during a visit to Orotava, Teneriffe, in April 1887 (about the time mentioned by your correspondent), I observed and gathered a quantity of pumice-stone upon the seashore, the high tide mark being literally strewed with it. It seemed probable that it had been deposited there some weeks or possibly months previously, as, had there been any quantity floating about in the sea, I should have noticed it, being engaged at the time tow-netting in the neighbourhood and in the adjacent Canary Islands. There was no evidence of vegetable debris having accompanied the pumice, nor did I notice any pieces with barnacles attached.

Liverpool, July 13. ISAAC C. THOMPSON.

A Curious Resemblance

WHILST walking by the sea on the cliffs last Sunday, I perceived at a distance of about 1500 yards a flight of nearly forty ducks, travelling at a good pace 2 or 3 feet above the level of the water. To me they appeared exactly what the so-called "sea-serpent" would, eight or ten of the birds flying close together and forming the head, whilst the rest trailed behind and formed the body and tail. At intervals they disappeared. This was caused, I think, by the birds changing their course and flying either directly away or towards me; the former, I believe, in my case.

Some time afterwards I saw two other flights, and these resembled the first exactly, those with me also being surprised at their "snake"-like appearance. W. J. LOCKYER.

Thanet, July 16.

The "Sky-coloured Clouds."

THERE was a very bright display of these clouds last night. I could not perceive anything of them up to 10 p.m., though the sky was clear, but by 10.18 they had become conspicuous, and were brightest, so far as I observed, near midnight.

I have seen very little account in any English paper of the visibility of these clouds beyond England, nor do I know whether they have been seen elsewhere than in Northern Europe. Has there been anything published on these points in English?

Neither have I seen any reference to the extensive observations of Herr O. Jesse at Steglitz, with his suggestions to observers. He considers it very important that this unusually favourable opportunity should be utilized for learning the motions of currents at great heights in the atmosphere. He suggests that photographs taken simultaneously from two places at a distance of say 20 kilomètres would be useful for ascertaining the height of the clouds; but for this purpose the necessity arises of being able to calculate very accurately the azimuths and altitudes of different points in the photograph. Their height can likewise be determined, though less accurately, by observations of the limit of sunshine upon them. Herr Jesse proposes another way also, viz. by throwing an intense beam of electric light on the clouds; but I should doubt the practicability of this.

The direction and rate of motion could be best made out, he says, by the use of a cloud-mirror. The changes that take place in the forms of the clouds before they have moved far make it difficult to ascertain their motion accurately.

Herr Jesse further thinks the intensity of the light of the clouds in different positions should be determined; also that the sky should be examined in the day-time with a polariscope and photometer in the hope that the presence of the matter of the clouds, then invisible to the eye, might be revealed.

Sunderland, July 13. T. W. BACKHOUSE.

An Unusual Rainbow.

SINGULARLY enough I can record the appearance of a rainbow after sunset similar to that described by Mr. S. A. Hill (NATURE, March 15, vol. xxxvii., p. 464). I was not aware there was anything unusual in it until I read Mr. Andrew's communication, or would have written to you about it. I do not remember on what day I saw the rainbow, but it was about the date of that observed by Mr. Andrew. I called my wife's attention to it, and attributed it to the brilliant glow of the sunset tints. It had a secondary bow, and Mont Kogie as a dark background. E. L. LAYARD.

British Consulate, Noumea, May 15.

TIMBER, AND SOME OF ITS DISEASES.[1]

IX.

IF the leaves are stripped from a timber-tree early in the summer, or during their young conditions in the spring, the layer of wood produced in the current year—and probably even that formed next year—will be poor and thin. This is simply a fact of observation, and does not depend on what agent deprives the tree of its leaves. Those oaks which suffered so greatly from the ravages of certain tiny caterpillars this last summer (1887)—many of them having all their leaves eaten away before July—will have recorded the disaster by a thin annual ring of wood: it is true the more vigorous trees produced (at the expense of what stores of food materials remained over) a second crop of leaves in August, and so no doubt the zone of wood will prove to be a thin double one, but it is at the expense of next year's buds.

[1] Continued from p. 170.

Now there are very many foes which injure the leaves of our timber-trees, and I wish to show, as clearly as possible in a short article, how it comes about that injury to the leaves means injury to the timber. The sum total of the matter is that the substances which are to be sent down to the cambium, and converted through its agency into wood, are produced in the cells of the leaves: consequently, from our point of view, when an insect or a fungus consumes the substance of the leaves, it consumes timber in prospective. Similarly, when the leaves are removed from a tree by any agent whatever, the latter is robbed in advance of timber. A leaf, generally speaking, is an extended, flattened portion of a branch, covered by a continuation of the epidermis of the branch, and containing a continuation of its other tissues—the vascular bundles of the branch being continued as the venation, and the cellular cortex reappearing as the green soft tissue of the leaf. The epidermis of the leaf is so pierced at hundreds or thousands of nearly equi-distant points, that gases can enter into or escape from all its tissues: at these points are the so-called *stomata*, each stoma being a little apparatus which can open and close according to circumstances.

These openings lead into excavations or passages between the loose cells of the softer leaf-tissue, and if we supposed a very minute creeping organism to enter one of the stomata, it would find itself in a labyrinth of intercellular passages: supposing it able to traverse these, it could pass from any part of the leaf to any other between the cells; or it could emerge again from the leaf at thousands of places—other stomata. In traversing the whole of the labyrinth, however, it would pass over many millions of times its own length. Moreover it would find these intercellular passages filled with a varying atmosphere of diffusing gases—oxygen, nitrogen, the vapour of water, and carbon-dioxide being the chief. It would also find the cell-walls which bound the passages damp, with water continuous with the water in the cells. If we suppose our hypothetical traveller threading the mazes of these passages at night, and able to perceive the changes which go on, it would find relatively little oxygen and relatively much carbon-dioxide in the damp atmosphere in the passages; whereas in the daylight, if the sun was shining brightly on the leaves, it would find the atmosphere rarer, and relatively little carbon-dioxide present, but an abundance of oxygen. These gases and vapour would be slowly moving in and out at the stomata by diffusion, the evaporation of the watery vapour especially being quicker on a dry, hot, sunny day.

Inside the cells between which these tortuous passages run, are contained structures which have much to do with these changes. Each of the cells I am considering contains a lining of protoplasm, in which a nucleus, and a number of small protoplasmic granules, coloured green, and called chlorophyll-corpuscles, are embedded: all these are bathed in a watery cell-sap.

Now, putting together in a general manner some of the chief facts which we know about this apparatus, it may be said that the liquid sap inside the cells gives off water to replace that which escapes through the damp cell-walls, and evaporates into the above-named passages and out through the stomata, or at the surface. This evaporation of the water is in itself the cause of a flow of more water from behind, and this flow takes place from the vascular bundles forming the so-called venation of the leaf, coming directly from the wood of the stem. The course of this water, then, is from the soil, through the roots, up the young wood and into the venation of the leaf, and thence it is drawn into the cells we are considering. But this water is not pure water: it contains in solution small quantities of salts of lime, potash, magnesia, nitric, sulphuric, and phosphoric acids, as well as a little common salt, and traces of one or two other things. It is, in fact, of the nature of ordinary drinking-water, which always contains minute quantities of such salts: like drinking-water, it also contains gases (oxygen, nitrogen, carbon-dioxide) dissolved in it.

It follows from what has been said that the cell-sap tends to accumulate small increasing quantities of these salts, &c., as the water passes away by evaporation. But we must remember that the living contents—the protoplasm, nucleus, and the green chlorophyll-corpuscles—use up many of these salts for their life-purposes, and other portions pass into the cell-walls.

It will thus be seen that the green chlorophyll-corpuscles are bathed by a fluid cell-sap, the dissolved gaseous and mineral contents of which are continually changing, even apart from the alterations which the life-processes of the living contents of the cell themselves entail. We may say that the chlorophyll-corpuscles find at their disposal in the cell-sap, with which they are more or less in direct contact, traces of salts, oxygen, carbon-dioxide, and of course water, consisting of hydrogen and oxygen.

Now we have the best possible reasons for knowing that some such changes as the following occur in these chlorophyll-corpuscles, provided they are exposed to sunlight: they take up carbon-dioxide and water, and traces of minerals, and by means of a molecular mechanism which is as yet unexplained in detail, they perform the astonishing feat—for it represents an astonishing transformation when regarded chemically and physically—of tearing asunder, by the aid of the light, the carbon, hydrogen, and oxygen of the carbon-dioxide and water, and rearranging these elements in part so as to form a much more complex body—starch or an allied compound, oxygen being at the same time set free.

It is of course not part of my present task to trace these physiological processes in detail, or to bring forward the experimental evidence on which our knowledge of them is based. It must suffice to state that these compounds, starch and allied substances, do not remain in the chlorophyll-[illegible] become dissolved and carried away through [illegible]els in the vascular bundles of the venation, and [illegible]ss to wherever they are to be employed as food. The chemical form in which these substances pass from one [illegible] to another in solution is chiefly that of grape-sugar, and [illegible] a comparatively easy observation to make that the [illegible] so often referred to contain such sugar in their sap.

We are only concerned [illegible] present with the fate of a portion—but a very large [illegible]ion—of this starch and sugar: we can trace them [illegible] the vascular bundles of the venation, through the lea[illegible], into the cortex, and eventually to the cambium-cel[illegible] it is necessary to be quite clear on the following poi[illegible]) the cambium-cells, like all other living cells which [illegible] in no chlorophyll, need to be supplied with such foo[illegible] sugar, starch, &c., or they starve and perish; (2) sinc[illegible]e foods are prepared, as we have seen, in the leav[illegible] in the leaves only, it is obvious that the vigour a[illegible]ll-being of the cambium depend on the functional ac[illegible] the leaves.

We have already seen how the [illegible]-cells give rise to the young wood, and thus it [illegible] clear how the formation of timber is dependent o[illegible]nctional activity of the leaves. Moreover, it ought [illegible]tioned, by the way at least, that it is not only [illegible]mbium which depends upon the leaves for its sup[illegible] the roots, young buds, flowers, and fruits, &c., [illegible] as the cortex and cork-forming tissues, are com[illegible] for the food supply. Now it is clear that if we [illegible]e buds there will be fewer leaves developed in th[illegible] year, and so next year's cambium will again [illegible] and so on.

I have by no means traced all the details of eve[illegible] first ra[illegible]fications of the complex network of correla[illegible] implied by this competition of the various organs [illegible] tissues for the food supplies from the leaves; but proba[illegible] the following proposition will be generally clear:—If th[illegible] leaves are stripped, the cambium suffers starvation to a greater or less extent, depending on the intensity of its competition with other tissues, &c.; of course a starved cambium will form less wood, and, it may be added, the timber will be poorer.

Again, even if the leaves are not stripped quickly from the tree, but the effect of some external agent is to shorten their period of activity; or to occupy space, on or in them, and so diminish the amount of leaf-surface exposed to the light and air; or to block up their stomata, the points of egress and ingress for gases and water; or to steal the contents of the cells—contents which should normally be passed on for the growth, &c., of other parts of the tree—in all or any of these ways injury to the timber may accrue from the action of the agent in question. Now there are numbers of parasitic fungi which do all these things, and when they obtain a hold on pure plantations or forests, they may do immense injury before their presence is detected by anyone not familiar with their appearance and life-histories.

The great difficulty to the practical forester who attempts to deal with these "leaf diseases" is at least twofold; for not only are the leaves so numerous and so out of reach that he can scarcely entertain the idea of doing anything directly to them, but (and this is by no means so clearly apprehended as it should be) they stay on the tree but a short time as a rule, and when they fall are a continual source of re-infection, because the spores of the fungi are developed on them. It is a curious fact that those fungi which are known to affect the leaves of forest-trees nearly all belong to two highly-developed groups—the Uredineæ and the Ascomycetes—and the remarkable biological adaptations which these parasites exhibit for attacking or entering the leaves, passing through periods of danger, and so on, are almost as various as they are numerous. Some of them, [illegible] the *Erysipheæ* or mildews on beeches, oaks, birches, ashes, &c., only form small external patches on the leaves, and do little if any harm where the leaf-crown is large and active; others, such as many of the very numerous *Sphæriaceæ* and their allies, which form small dark-coloured flecks and spots on leaves, may also be looked upon as taking only a slight tax from the leaves. Even in these cases, however, when the diseases become epidemic in certain wet seasons, considerable damage may accrue, because two chief causes (and many minor ones) are co-operating to favour the fungus in the struggle for existence: in the first place, a continuously wet summer means loss of sunlight and diminished transpiration, &c., to the leaves, and so they form smaller quantities of food materials; and secondly, the damp in the atmosphere and leaves favours the fungi, and so they destroy and occupy larger areas of leaf surface.

It should be mentioned here, by the way, that all leaves of all trees are apt to have fungi on them in a wet summer, but many of these are only spreading their mycelia in all directions over the epidermis, in preparation, as it were, for the fall of the leaf: they are saprophytes which feed on the dead fallen leaves, but cannot enter into them while yet alive. In some cases, however, this preparation for the fall is strikingly suggestive of adaptation towards becoming parasites. I will quote one instance only in illustration of this. On the leaves of certain trees in Ceylon, there was always to be found in the rainy season the much-branched mycelium of a minute *Sphæria*: this formed enormous numbers of branches, which, on the older leaves, were found to stop short over the stomata, and to form eventually a four-celled spore-like body just blocking up each stoma on which it rested. So long as the leaf remained living on the tree, nothing further occurred; but wherever a part of the leaf died, or when the leaf fell moribund on the ground, these spore-like bodies at once began to send hyphæ into the dying tissue, and thus obtained an early place in the struggle for existence among the saprophytes which finished the destruction of the cells and tissues of the leaf.

There is another group of fungi, the *Capnodieæ*, which form sooty black patches on the leaves, and which are very apt to increase to a dangerous extent on leaves in damp shady situations: these have no connection with the well-known black patches of *Rhytisma* from which the leaves of our maples are rarely free. This last fungus is a true parasite, its mycelium penetrates into the leaf tissues, and forms large black patches, in and near which the cells of the leaf either live for the benefit of the fungus alone, or entirely succumb to its ravages: after the leaf has fallen, the fungus forms its spores. Nevertheless, although we have gone a step further in destructiveness, foresters deny that much harm is done to the trees—no doubt because the foliage of the maples is so very abundant. Willows, pines, and firs suffer from allied forms of fungi.

But it is among the group of the *Uredineæ* or rusts that we find the most extraordinary cases of parasitism, and since some of these exhibit the most highly developed and complex adaptations known to us, I propose to select one of them as the type of these so-called "leaf diseases." This form is *Coleosporium Senecionis* (*Peridermium Pini*), rendered classical by the researches of several excellent botanists.

It is true, *Coleosporium Senecionis* is not in some respects the most dangerous of these fungi—or, rather, it has not hitherto been found to be so—but in view of the acknowledged fact that foresters have not as yet been able to devise practical measures against the ravages of these numerous rust-fungi, and since we are as yet very ignorant of the details of the biology of most of them, it seems advisable to choose for illustration a form which shows in a distinct manner the complexities of the subject, so that those interested may see in what directions biologists may look for new results. That the story of this fungus is both complicated and of great biological interest will be sufficiently evident from the mere recital of what we know concerning it.

H. MARSHALL WARD.

(*To be continued.*)

MICHELL'S PROBLEM.

FOR the last two hundred years the attention of logicians and mathematicians has been directed to the inverse principles of the theory of probability, in which we reason from known events to possible causes. Two different methods of calculation are in use, which give approximately the same results. According to the celebrated theorem of James Bernoulli, "If a sufficiently large number of trials is made, the ratio of the favourable to the unfavourable events will not differ from the ratio of their respective probabilities beyond a certain limit in excess or defect, and the probability of keeping within these limits, however small, can be made as near certainty as we please by taking a sufficiently large number of trials." The inverse use of this theorem is much more important and much more liable to objection and difficulties than the direct use. In the words of De Morgan, "When an event has happened, and may have happened in two or three different ways, that way which is most likely to bring about the event, is most likely to have been the cause."

The second principle, due to Bayes, is thus given by De Morgan, "Knowing the probability of a compound event, and that of one of its components, we find the probability of the other by dividing the first by the second."

These principles have been accepted by the great majority of thinkers, and freely used by Laplace, Poisson, Herschel, and De Morgan. Stanley Jevons ("Principles of Science") gives a luminous account of the value of the theory, and accepts Michell's views: "If Michell be in error, it is in the methods of calculation, not in the general validity of his reasoning and conclusions."

On the other hand, Leibnitz, Kant, Forbes, Boole, and Mill ("Logic," xvii., xviii., xxv.), while allowing some value to the theory, doubt if it can be rigorously applied to obtain definite numerical results.

The interest and importance of the subject, and the length of time which has elapsed since any detailed discussion of it has been undertaken, furnish an excuse for the following suggestions, which are made in the hope that they may elicit more valuable arguments and opinions.

More than a century ago, Michell (Phil. Trans., 1767, p. 243) attempted to find the probability that there is some cause for the fact that the stars are not uniformly distributed over the heavens, but frequently form binary combinations or larger groups. Michell's results are quoted with approval by Laplace ("Théorie des Prob," p. 63), and by Herschel ("Astronomy," p. 607), though the latter mentions that Michell's data are too small, and immediately afterwards quotes Struve's solution of the same problem, which seems to be inconsistent with Michell's. I select Michell's problem for discussion, since it has been accepted by high authority and vigorously attacked, and for the sake of simplicity in the calculations shall confine my remarks to binary combinations.

Michell's statements are not very clear, and his arithmetical methods are cumbrous, but his argument may be condensed as follows: "What, it is probable, would have been the least apparent distance of any two or more stars anywhere in the whole heavens, upon the supposition that they had been scattered by mere chance?" Imagine any star situated on the surface of a sphere ($S = 4\pi r^2$) of radius r, and surrounded by a circle of radius a ($= r \sin\theta$, where θ is the angle subtended by a at the centre of the sphere), the area of this small circle is $s = \pi a^2 = \pi r^2 \sin^2\theta$. The probability that another star, "scattered by mere chance," should fall within this small circle is $\frac{s}{S}$, and that it should not fall within it $\frac{S-s}{S}$. But there is the same chance for any one star as for any other to fall within the circle, hence we must multiply this fraction into itself as many times as the whole number of stars (n) of equal brightness to those in question. "And farther, because the same event is equally likely to happen to any one star as to any other, and therefore any one of the whole number of stars (n) might as well have been taken for the given star as any other, we must repeat the last found chance n times, and consequently $\left(1 - \frac{s}{S}\right)^{n^2}$ will represent the probability that nowhere in the whole heavens any two stars among those in question would be within the given distance (a) from one another, and the complement of this quantity to unity will represent the probability of the contrary."

In the case of the two stars, β Capricorni, Michell takes $n = 230$, $\theta = 3' 20''$. Hence

$$p = \frac{s}{S} = \frac{(\sin 3' 20'')^2}{4} = 1/4254519,$$

which Michell takes as $1/4254603$; and

$$Q = \left(1 - 1/4254603\right)^{n^2} = 1 - \frac{52900}{4254603} = 1 - 1/80{\cdot}4;$$

or, according to Michell, the probability is 80/81 that no two stars equal in size to β Capricorni shall fall so near to one another as they do.

Prof. J. D. Forbes (*Phil. Mag.*, December 1850) objects to the entire principle upon which Michell's work is based, and has pointed out some errors in detail. Todhunter ("Theory of Prob.," p. 334) and Boole ("Laws of Thought," p. 365) countenance these objections; but before discussing them it will be well to mention other attempts to solve the same problem.

Struve ("Cat. Nov.," p. 37) has used an entirely different method. The possible number of binary combinations of n stars is $\frac{n(n-1)}{1 \cdot 2}$; and the chance that such a pair should fall on a small circle of area s is s/S, where S is the surface of the portion of the sphere in which n has been counted. Hence the chance that any pair of stars should fall within the circle is $n(n-1)s/2S$.

Taking S as the surface from $-15°$ of declination to the North Pole, $n = 10229$, and $\theta = 4''$, Struve finds $p = 0{\cdot}007814$.

Herschel ("Ast.," p. 607), either in error or by a recalculation from different data, quotes Struve as finding that the probability is 1/9570 against two stars of the 7th magnitude coming within 4″ by accident.

Applying Struve's formula to Michell's data for β Capricorni, we have

$$1 - \frac{230 \times 229}{2} \times \frac{1}{4254603} = 1 - 1/161{\cdot}5,$$

or 161/162, as the probability that no two such stars fall within the given area.

Forbes, with the aid of a mathematical friend, offers the following solution:—Suppose the n stars are represented by dice, each with $v(>n)$ sides, where v represents the number of small circles in the spherical surface, or S/s. The chance of two stars falling into one circle is the same as that two dice show the same face.

The total number of arrangements without duplication is—

$$v \,.\, \overline{v-1} \,.\, \overline{v-2} \,.\,.\,.\, \overline{v-n+1},$$

and the total number of [illegible] v^n; hence the probability of a fall without duplication [illegible]—

$$v \,.\, \overline{v-1} \,.\, \overline{v-2} \,.\,.\,.\, \overline{v-n+1}/v^n;$$

and the chance that two or more dice show the same face is—

$$1 - \lfloor v / \lfloor v - n \,.\, v^n.$$

In the case of β Capricorni $v = 4254603$, and $n = 230$. Evaluating by Stirling's theorem, Forbes gives $p = 0{\cdot}00617 = 1/160$ nearly, which does not differ much from $n^2/2v$.

A recalculation has given me $p = 1/162$. The result then agrees with that of Struve and differs from that of Michell.

The following suggestions are due in substance chiefly to Boole and Forbes, but their language has been freely altered, and misapprehension of their meaning may therefore be feared.

In all such cases an hypothesis ("the random distribution of stars") is assumed, and the probability of an observed consequence ("the appearance of a double star") calculated. The small probability of this result of the assumed hypothesis is held to imply that the probability of the hypothesis is equally small, and therefore the probability of the contrary hypothesis is very large.

According to Boole, "the general problem, in whatever form it may be presented, admits only of an *indefinite* solution," since in every solution it is tacitly assumed that the *a priori* probability of the hypothesis has a definite value, generally 0 or 1, and also a definite probability is assigned to the occurrence of the event observed if the assumed hypothesis were false.

In Michell's problem it is assumed that the stars are either scattered at random or obey a general law: no notice is taken of the possible case that a general law holds for stars within a certain distance from our system, beyond which an entirely different law may obtain. Again, the subjection of each system to a separate intelligence is tacitly ignored.

The probability of an event is the value of the expectation of its occurrence existing in the mind of the thinker: "We must again warn the reader that probabilities are in his mind, not in the urn from which he draws" (De Morgan, "Enc. Met.," 414); but in the solution of these problems this subjective value is converted with startling ease into a much more objective and concrete expression. As Forbes puts it, "The doubt existing whether an event still future, which may happen in many different ways, shall occur in one particular way is not equivalent to an inherent improbability of its happening, or having happened, in that way"

We do not assume that a friend is speaking untruly when he tells us that, out of 10001 seats, the number of his ticket is 453, yet the antecedent probability is 1/10000 against the truth of his statement. The chances are greatly against ten stars out of 230 appearing as binary combinations; but, according to one view of the meaning of "random distribution," that arrangement is no more unlikely than any other, and we should be no more surprised to hear that one rather than another is the actual one. Forbes objects that "to assume that 'every star is as likely to be in one position as another,' is not the expression of the idea of random or lawless distribution." The expression seems to me to be true, but its interpretation into mathematical symbols has been far too closely restricted both by Michell and Forbes.

"Michell assumes that, with random distribution, the chance of finding a star in a space is proportional to the space, or that a perfectly uniform distribution would be that alone which would afford no evidence of causation."

Suppose the whole surface of the sphere cut up into minute equilateral triangles, and a star placed at each collection of angular points. Each star is the middle point of a regular hexagon, and at a distance, a, from six other stars. If we imagine the six stars to be fixed, and the central star shot out from the centre of the sphere so as to fall within the hexagon, that it may not fall within a distance, r, of any other star it must fall in a regular hexagon, the side of which is $(a - r)$ situated symmetrically within the larger hexagon. The probability of the star falling within this smaller hexagon is expressed by $\frac{(a-r)^2}{a^2}$, which becomes less and less the more nearly r equals a; that is, the more nearly the distribution is truly uniform. When $r = a$, the expression becomes 0, or the probability of exactly uniform distribution is *nil*, and apparently uniform distribution is due solely to the imperfections of our instruments. Michell, however, seems to assume this probability to be 1, or certainty. Struve's method is open to the grave objection that he assumes that the total possible number of binary combinations really occur. Applying his formula to calculate a value for n which makes the chance a certainty, he found that, if 2917 stars are scattered over the sphere, it is a certainty that each will be withinf 3′ 20″ of another! Of the three methods, that of Forbes seems to be the least open to objection.

Besides these fundamental difficulties in principle, there are several very doubtful points in the calculation which may be worthy of a brief notice.

Michell considered the whole surface of the sphere, though in his time the examination of the southern hemisphere was hardly complete enough to furnish the requisite data. The stars do not lie on the surface of a sphere, but scattered through infinite space, so that two stars, the angular distance between which is apparently small, may in reality be very far apart. Suppose that the nearer star lies on the surface of our imaginary sphere, the probability that the direction of the other star is within 15° of the surface is only about one-fourth. Hence the number of apparently double stars must be reduced to a considerable but unknown extent.

Forbes throws considerable doubt on the correctness of raising a second time to the power n. Struve's multiplication by n's seems to prove very curious conclusions. Mr. Venn's reasons for dissenting from Michell's solution will be found well worthy of perusal ("Logic of Chance," p. 260).

SYDNEY LUPTON.

VEGETABLE RENNET.

THE idea that the protoplasm or living substance of both animals and plants is essentially similar, if not quite identical, has long been accepted by both physiologists and botanists. This similarity is most easily seen in the very lowest members of both kingdoms; in fact, for a very long time doubt existed in the case of many organisms—*e.g.* Volvox—as to which kingdom they should properly be included in. Even now it is hardly possible to formulate a definition of "plant" or "animal" which shall put all into their proper positions. When we go higher up the scale in both the animal and the vegetable world, this difficulty of course disappears, on account of the differences of organization and development. It is not difficult even here to trace a remarkable similarity of properties in the living substance, which leads to the conception that not only is protoplasm practically the same in animal and vegetable, but that its activities in the two cases—that is, the metabolic processes which accompany, and are in a way the expression of, its life—are fundamentally the same. In both kingdoms we have as the sign of its life the continual building up of the living substance at the expense of the materials brought to it as food, and the constant breaking down of its substance with the consequent appearance of different organic bodies, which are strictly comparable in the two cases. The vegetable protoplasm produces starch, the animal glycogen—both carbohydrate bodies of similar composition and behaviour. In both organisms we meet with sugars of precisely similar character. The proteid bodies long known to exist in animals, and classed into albumins, globulins, albumoses, peptones, &c., have been found to be represented in vegetables by members of the same groups, differing but in minor points from themselves. We have fats of complex nature in the animal represented by oils of equal complexity in the vegetable, their fundamental composition being identical; even the curious body lecithin, so long known as a constituent of nervous tissue in the animal, having been procured from the simple yeast plant.

Further, the changes which give rise to these bodies, or which bring about various transformations of them, have been in very many cases demonstrated to be due to similar agencies at work in both the animal and vegetable organism In many cases, no doubt, they are produced by the actual splitting up of the protoplasm itself; but apart from this we have their formation in large quantities by the agency of bodies which are known as unorganized ferments, and which are secreted by the protoplasm for the purpose of such formation. Perhaps no line of research in vegetable physiology in recent years has been so productive of good results as the investigations that have been made into the occurrence of such bodies, and the comparison of them with those that are met with in the animal organism. Diastase in vegetables, and the ferments of saliva and of pancreatic juice in animals, possess the same power of converting starch into sugar. The peptic and tryptic ferments of the stomach and pancreas respectively have been shown to have representatives in the vegetable kingdom, and these not only in such cases as the carnivorous plants, but to be actually made use of in such truly vegetable metabolism as the processes involved in the germination of the seed. The conversion of albumins and other indiffusible proteids into a further stage than that of diffusible peptone—

that of leucin in the animal, and asparagin in the vegetable—has been shown to be the work of such a ferment in the two cases. These ferments, too, are interchangeable to a certain extent, for those of the alimentary canal are capable of digesting the proteids of vegetable bodies, while those of the latter can similarly split up the animal albumins, fibrin, and other forms of proteid.

The essential similarity of the metabolism is also indicated by the appearance in the two cases of complex bodies of somewhat similar constitution which are quite comparable with each other. In the vegetable kingdom these bodies are known as alkaloids ; in the animal they have for the past ten years or more been known as ptomaïnes. They are among the products of the destructive decomposition of proteids. Thus *cadaverin*, a body found in putrefying animal matter, is apparently to be looked upon as belonging to the same group of bodies as *muscarin*, the poisonous principle found in several species of mushroom.

Perhaps the latest development of the same idea has been the discovery of ferments in the vegetable kingdom which are comparable in their action with the rennet which is obtainable from the stomach of many young animals, particularly the calf. In an extract of such a stomach taken while secretion of gastric juice is proceeding, or in the gastric juice itself, is a principle which has the power of curdling milk—a property taken advantage of by the farmer in the process of manufacturing cheese. The *casein*, which is the proteid concerned in cheese-making, is, under appropriate conditions, converted by this body into an insoluble form, which, for want of a better name, may be called briefly cheese. The conversion is not to be confused with the loose curdling which takes place when milk becomes sour from putrefactive changes or from the addition of an acid, for it is a true coagulation, resembling the clotting of blood. Now, recent investigations show us that in many plants a similar ferment exists, which possesses an identical power, producing, when added to milk, a clot which is quite indistinguishable from that which is formed under the action of animal rennet. The list of such plants is continually increasing, but they do not appear to be grouped at all on the lines of the recognized natural orders. Ranunculaceæ, Solanaceæ, Cucurbitaceæ, Compositæ, Galiaceæ, and others, furnish us with conspicuous examples.

At a meeting of the Society of Natural Science of Stockholm, held about four years ago, the Secretary brought before the notice of the meeting the fact that the common butterwort (*Pinguicula vulgaris*) possessed the very curious property of causing a clotting of milk when the vessels in which the milk was contained had been first rubbed over with the plant. No explanation was offered of the phenomenon, but a suggestion was made that the power might be due to the presence of micro-organisms. Judging from analogy with other plants since discovered to possess the same property, it is far more likely to be due to a specific unorganized ferment. The occurrence of this in Pinguicula is very significant, as bearing on the similarity of the metabolism in animals and vegetables, for Pinguicula is one of the carnivorous plants, digesting, by the aid of its secretions, flies which it captures in its leaves. We have so associated in the same plant a proteolytic and a rennet ferment, a condition which at once recalls the gastric juice of animals, in which both these bodies are present.

One of the most interesting of the plants which contain this ferment, or vegetable rennet, is the so-called "Naras" of the West Coast of Africa (*Acanthosicyos horrida*), a species of Cucurbitaceæ. The plant was described in detail by Welwitsch, in 1869, when its peculiar physiological property was unknown. A more detailed description, given by Marloth, has recently appeared, which deals, among other points, with this power. The plant is to be met with in dry, sandy, and desert places in Namaqua Land, Whale Bay, and the Mozambique district. It is very singular in its habit and appearance, consisting of long, spiny, weak-looking branches running almost on the surface of the sand, and being at intervals buried therein and again emerging. The stem is very short, so that the plant looks like a system of creeping spiny branches, some of which measure 20 feet or more in length. The root system is similarly developed, long creeping roots penetrating, in some cases, for a distance of 100 feet through the sand. The long spiny branches seem destitute of leaves, for these are quickly deciduous and sometimes abortive, and while they remain upon the shoots they are closely adpressed to them, and are stiff and horny in texture. At the base of each leaf are two strong spines, which persist after the leaf has fallen. The flowers are borne in the axils of the leaves, between the spines. The male and female flowers are found on separate plants ; the former are sessile, the latter shortly stalked. The ripe fruit is of considerable size, much like an orange in appearance. It has a very powerful and pleasant aroma, and its pulp is very juicy and agreeable to the taste. In the unripe condition it is bitter and uneatable. According to Marloth, the natives eat it to a very great excess, both fresh and in the form of "Naras cake," a preparation of it made by drying the expressed pulp and juice in the sun. The power to appreciate its excellence seems to be confined to the natives of the part, for strangers partaking of it for the first time are said to pass through strange and painful experiences after their banquet.

Its power of causing the clotting of milk is well known among the natives of the part, who use it freely for that purpose. The ferment is contained in considerable quantity in the juice, the pulp, and the rind of the fruit. It is absent from the branches, from the seeds, and from all parts of the unripe fruit. It is soluble, according to Marloth, in alcohol of 60 per cent. strength, an extract of the pulp made with that fluid retaining the power to coagulate the milk. It is not identical with the principle which gives the fragrance to the ripe fruit, nor to that which gives the bitter taste to it when still young. The ferment is destroyed by boiling, but will remain for an almost indefinite time in the dried rind. Marloth, in his experiments, found that an extract of pulp dried to a friable condition in the sun was quite active in causing coagulation. The writer had the opportunity recently of examining some dried rind and some old seeds.[1] An extract of these materials, made with 5 per cent. solution of common salt, showed the ferment in abundance in the rind, but absent from both the testa and the interior of the seeds.

Another plant, occurring nearer home, has the same property. This is the common yellow Galium (*G. verum*). In his "Popular Names of British Plants," Prior speaks of its peculiarity as being known in the sixteenth century, when Matthioli wrote thus, "Galium inde nomen sortitum est suum quod lac coagulet." In the West of England, particularly in Somersetshire and Herefordshire, it is still the custom of dairymen to put this plant into the milk they have devoted to cheese production, to "set" it. The plant has a long straggling stem, bearing at short intervals whorls of small leaves, in the axils of which are numerous panicles of yellow flowers. The practice is to put the whole plant, or as much of it as is above ground, into the milk, but the active principle seems to be located in the flowers. The white Galium (*G. Aparine*) is said to be devoid of the property.

The common traveller's joy (*Clematis Vitalba*) is another instance of the occurrence of this ferment. It is peculiar in one respect, the property appearing to be

[1] This material was kindly furnished by Mr. W. Thiselton Dyer, F.R.S., Director of the Royal Gardens, Kew.

situated in the tissue of the stem, probably the soft bast. In most other cases it seems to be attached somehow to the reproductive parts of the plant. The quantity that can be extracted from Clematis is, however, much less than from the other plants spoken of.

The ferment has also been found in the petals of the artichoke (*Cynara Scolymus*).

An account of the occurrence of this vegetable rennet would not be complete without its including the researches of Dr. Sheridan Lea on *Withania coagulans* (Proceedings of the Royal Society, 1883). These have, besides their scientific value, a direct bearing upon the commercial aspect of the question. Many of the natives of India refuse to have anything to do with cheese prepared by means of animal rennet, and there is consequently there a large field for the employment of the plant. Some years ago Surgeon-Major Aitchison sent home an account of the peculiar property of the Withania. The shrub grows freely in Afghanistan and Northern India, and the natives there have for a long time employed an aqueous extract of the capsules to curdle their milk. Some dried material sent from thence to Kew was used by Dr. Lea in his investigations. Withania is a genus of the order Solanaceæ, and has a capsular fruit, containing a large number of small seeds. In the dried material these seeds were enveloped in a coating of a peculiar resinous matter, which was probably the dried juice of the capsules in which they had ripened. The ferment was found to exist to a very slight amount in the stalks of the fruits, and to be extremely abundant in the seeds. From the ground seeds it could be extracted easily by maceration with solution of common salt and by treatment with glycerine. So extracted, it was found to be destroyed on boiling, but to be able to withstand moderately prolonged exposure to alcohol. Its activity in a fairly strong extract was quite equal to that of most commercial samples of rennet prepared from the stomach. It could, moreover, be kept with as great security as the latter by the aid of common salt and a little alcohol. Its commercial value is somewhat interfered with by the presence in the seeds, and in their extracts, of a peculiar yellowish-brown colouring-matter, which cannot be separated without destroying the rennet.

Since the publication of Dr. Lea's researches the writer has met with the ferment in the unripe seeds of *Datura Stramonium*, a plant belonging to the same order, Solanaceæ. In this plant, though present in the unripe seeds, it appears to be absent from them when ripe. Its exact distribution is, however, not yet determined.

The occurrence of this property in so many plants, and these not at all closely connected in other ways, leads to the consideration of what must be its physiological significance. It is perhaps not difficult to see why rennet should occur in the stomachs of young animals whose food consists chiefly of milk, but its importance in the vegetable kingdom must be independent of such a function. Further researches, still in progress, may perhaps throw some light upon this point. It is significant so far to notice that its occurrence is mainly in those parts which are especially connected with the reproduction of the plant, a fact which seems to point to a possible function in connection with the storage of proteid food materials for the nutrition of the embryo during germination. J. R. GREEN.

THE METEORIC SEASON.

WE have now arrived at a period of the year which is full of interest to meteoric observers. The number of meteors visible has greatly increased, as compared with preceding months, and apart from this, observations may be pursued without the discomfort and inconvenience so often experienced on the cold starlight nights of autumn and winter. The impending return of two rich showers is an additional incentive to those who may contemplate giving a little time to this interesting branch of astronomy.

From observations at Bristol on the nights of July 8, 11, and 12 last, it appears certain that the *Perseids* (which attain a maximum on August 10, when the radiant is at $45^{\circ} + 57^{\circ}$) had already commenced. On July 8 twenty-five meteors were counted between 11h. and 13h. 30m., and these included six paths which denoted a well-defined radiant at the point $3^{\circ} + 49^{\circ}$, a little south of Cassiopeia's Chair. The visible traits of the individual meteors traced from this radiant were identical with those exhibited by the *Perseids* which are displayed in August, and the fact that this radiant seen on July 8 is far west of the radiant usually remarked on August 10, does not negative the presumed identity of the two showers. The *Perseid* radiant which endures a considerable time, changes its position amongst the stars from night to night, and the extent and direction of this displacement will be seen by a reference to NATURE, vol. xxxvi. p. 407, where I have described a number of observations secured at this station in July and August of last year.

When the moon leaves the evening sky towards the close of the present month, observers should watch for the reappearance of the *Aquarids* which are usually seen in marked abundance about July 27, 28, and 29. The radiant is near δ Aquarii, and the meteors are rather slow, usually ascending from low in the south-east, and the brighter ones throw off trains of sparks. Early *Perseids* are also numerous at the end of July, and the radiant is then closely south of the well-known star cluster χ Persei. Observers should register the paths of the meteors and determine the precise place of the radiant on each night of observation.

Bristol, July 13. W. F. DENNING.

NOTES.

THE proposal that a Professorship for the exposition of the Darwinian theory should be established in connection with the Sorbonne has received the sanction of the Sorbonne authorities. Three members of the Committee by which the matter was decided were opposed to the scheme, but they did not vote against it. They simply refrained from voting. The Sorbonne has asked that the name of the proposed chair shall be changed. One or other of the three words, "evolution," "morphology," "phylogeny," is to be substituted for "philosophy."

THE Birmingham meeting of the Photographic Convention of the United Kingdom will be held from the 23rd to the 28th of July. A programme of excursions and local arrangements has been issued. The Convention will be opened on the evening of the 23rd inst., by the Mayor of Birmingham, at a *conversazione* to be held in the Masonic Hall in connection with an exhibition of photographs and photo-apparatus.

ON Thursday, the 12th inst., the anniversary meeting of the Sanitary Institution of Great Britain was held in the theatre of the Royal Institution. The Chairman, Mr. Edwin Chadwick, in opening the proceedings, claimed credit for the Sanitary Institution of Great Britain and like institutions for a large proportion of the reduced death-rate of the metropolis, which was now 14 in 1000. London in that respect compared very favourably with other places, the death-rate in Paris being 27, Vienna 30, and St. Petersburg 40. The medals and certificates awarded to the exhibitors at the Sanitary Exhibition held at Bolton in 1887 having been distributed by Mr. Chadwick, Dr. B. W. Richardson delivered an address on "The Storage of Life as a Sanitary Study." He began by referring to instances of long life in lower animals and in man. These, he said, by some peculiar process as yet but little investigated, held life as a long possession, and to this faculty he applied the term "The Storage of Life." The problem which the lecturer placed before the society was stated as follows:—Certain proofs of the power of the human body to lay or store up life to a prolonged period are admitted. What are the conditions which favour such storage, and how can we promote the conditions which lead to it? He stated the conditions in the following order, hereditary qualification, the virtue of continence, maintenance of balance of bodily functions, perfect temperance, and purity from implanted or acquired diseases. In estimating the value of temperament as connected with life storage, he maintained that the bilious and sanguine temperaments are best for long life, the nervous and lymphatic the worst. In dealing with what he called all-round temperance, he showed that whatever quickened the action of the heart beyond its natural speed and force was a stimulant, and in proportion to the unnatural tax inflicted by stimulation there was a reduction in the storage of life. Dr. Richardson spoke also of the prevention of the damaging diseases, where the art of the sanitarian comes into most effective play. A vote of thanks was accorded to the lecturer.

THE annual meeting of the Liverpool Astronomical Society was held at Liverpool on the 9th inst., when the report of the Council for the past year was read. It appears that since the last annual meeting more than 200 new members have been elected, and that the work carried on by the Society has increased in a commensurate degree. The balance sheet shows a small sum in the hands of the treasurer, so that the financial condition is satisfactory, though there has been a large outlay for printing the Journal. Mr. T. G. E. Elger succeeds Mr. Denning as President, and Mr. Rowlands is appointed Secretary in the place of Mr. W. H. Davies, who has resigned. In commenting upon the withdrawal of Mr. Davies, the Council refer to the earnestness, zeal, and ability displayed by him in performing the arduous duties of his office during a long period, and attribute the rapid development of the Society to his untiring efforts on its behalf.

THE thirty-fifth General Meeting of the German Geological Society will be held at Halle from August 13 to 15.

WE regret to announce the death of M. Jean-Charles Houzeau de Lehaie, Honorary Director of the Royal Observatory of Brussels, member of the Belgian Royal Academy of Sciences. He died at Schaerbeck on the 12th inst. M. Houzeau was in his sixty-eighth year.

THE death is announced of Dr. Johann Odstreil, an eminent mathematician and physicist of Vienna.

A LOWER THAMES VALLEY BRANCH of the Selborne Society has been formed. Its operations will extend on both sides of the river from Hampton to Putney inclusive. The inaugural meeting was held on Monday in the coffee-room of the Star and Garter Hotel, Richmond, the Duke of Cambridge in the chair. The objects of the Selborne Society are to secure the preservation from unnecessary destruction of such wild birds, animals, and plants as are harmless, beautiful, or rare; to discourage the wearing and use for ornaments of birds and their plumages, except when the birds are killed for food or reared for plumage; to protect places and objects of interest or natural beauty from ill-treatment or destruction; and to promote the study of natural history. It is proposed that the new branch of the Society shall devote a part of its funds to the purchase of works on natural history for the free libraries of Richmond, particularly such as throw light upon the natural history of the Thames Valley, and encourage a love of nature in the young.

THE first Annual Report of the National Association for the Promotion of Technical Education has now been issued. It contains a full account of the objects and work of the Association. Its main work up to the present may, according to the Report, be roughly divided as follows:—(1) the publication of leaflets, pamphlets, addresses, and other papers, and the circulation of this literature throughout the country; (2) the holding of public meetings and conferences, and the delivery of lectures and addresses on subjects connected with the work of the Association; (3) Parliamentary work; (4) formation of an agricultural section; (5) commercial education; (6) the organization of branches and local committees to co-operate with the Central Association. Besides the work falling under these heads, the Association has been the means of supplying much information to inquirers on various subjects connected with technical education, and has promoted the movement in other ways. The committee are strongly of opinion that there is a wide field for the future operations of the Association. They urge that branches should be started in all large towns which are now without them, and that every opportunity should be taken by conferences, and in various other ways, to spread sound information on the question of technical education, on which, as the Report truly says, in spite of the great increase in public interest, much lamentable ignorance still remains.

THE Indian Government has adopted an important resolution on the subject of State education. It recommends that wherever possible Government schools should be substituted for private ones, and that the education staff should be strengthened by the engagement of specialists in Great Britain. The resolution deals largely with the question of technical education, and urges that as a beginning an industrial survey should be made of each province.

HAVING been charged with the supervision of a new and complete edition of the "W rks of Galileo," to be shortly undertaken at the expense of e Government and under the patronage of the King of Italy, Prof. Antonio Favaro, of the Royal University, Padua, earnestly begs all librarians, curators or trustees of museums, collectors of old manuscripts and autographs, and all those engaged in researches touching the history of science, to give him any information in their power respecting any Galileian documents, which may assist him in carrying out this difficult undertaking.

AT the meeting of the Scientific Committee of the Royal Horticultural Society on July 10, the plague of caterpillars, &c., was one of the subjects discussed. Mr. O'Brien alluded to the abundance of earwigs (Forficula) this season. Mr. Wilson drew attention to the local distribution of the caterpillars. In one garden in his neighbourhood none of the pests were found, while in others there was scarcely a leaf left on the trees. At Wisley Mr. Wilson had found that exposure to east wind was associated with the presence of the insects. Thus the trees in one line of plums, fully exposed, were stripped of their foliage, while in another line of the same variety close by, on the same description of soil, but where the trees were sheltered by a furze fence, not a leaf was injured.

THE Kew Bulletin for July opens with a paper containing much information on Bhabur grass, which closely approaches esparto in habit and in the possession of the technical qualities necessary for paper manufacture. In another paper there is an interesting extract from a letter by Mr. William Fawcett, giving his first impression of the vegetable resources of the Cayman Islands, which are situated in the Caribbean Sea, about 200 miles to the west of Jamaica. In association with the Governor of Jamaica Mr. Fawcett lately visited these lonely and little-known islands for the purpose of investigating a disease which has existed for some time among the cocoa-nut palms at Grand Cayman. Valonia in Cyprus and prickly pear in South Africa form the subjects of two other sections; and the number closes with an account of the true star anise of China, prepared by Sir J. D. Hooker for the current issue of the Botanical Magazine.

THE Annual Report of the Royal Botanic Gardens, Trinidad, for 1887, by Mr. J. H. Hart, Superintendent, has been issued. In an interesting historical sketch Mr. Hart notes that the Trinidad garden has been in existence seventy years, and is the oldest botanical garden which has been continuously maintained in working order within the circuit of the British West Indies. Mr. Hart was appointed Superintendent in 1886, and assumed charge in March, 1887, after eleven years' service in Jamaica. One of his first objects was to make provision for the proper arrangement and storage of herbarium specimens, and he is able to report, thanks chiefly to the interest in the matter taken by the Governor (Sir W. Robinson), that the herbarium is already established on a sound basis. He hopes that when the material is all arranged it will be among the first of West Indian herbariums, if not the very first. "To show the value of such work," says Mr. Hart, "and especially the value attached to the Trinidad flora, I may state that I have already received four applications for sets of the Trinidad plants; as these will bring exchanges from a like number of countries possessing a flora of great value to us for the comparison and identification of our own, these offers will be taken up as early as possible. Prof. W. Thiselton Dyer, Director of Kew, in a letter recently received, says: 'In Trinidad itself there must be an enormous amount of work still to be done.' Trinidad stands unique among the other islands by the possession of a flora which combines the West Indian with the South American, an has besides many plants which are only known to occur with wn boundaries, or, in other words, are pecular to the islar

ACCORDING to intelligence re ew York on July 14, Honduras had been visited by vere storms and earthquake shocks, which had caused grea amage to property, but no loss of life.

THE fourth yearly report of the Berlin branch of the German Meteorological Society for the year 1887, shows that the number of members has increased from thirty-seven in January, 1884, the time of its foundation, to 117. The President for the year 1888 is Dr. Vettin. The proceedings of the monthly meetings have been reported in our Notices of Societies, &c. The present report contains an account of the special rainfall investigations at twenty stations in and near Berlin, and comparisons of the different rain gauges employed.

THE British Consul at Bussorah on the Persian Gulf in his last report states that a remarkable improvement has taken place in the climate of the country round Bussorah with the substitution of date d wheat cultivation for that of rice. The malarious fev to which Bussorah gave its name, is now comparativel re; and sallow complexions and worn looks, which some ars ago were universal, are now no longer seen. The north- est wind, which prevails in the hot weather, instead of being ist and clammy, as it used to be, is dry and hot. The month of September, when the marsh which is formed yearly by the overflow of the Euphrates is drying up, is still the least healthy season. December and January are cold, July and August intensely hot. The rest of the year is very much like the spring and summer of Southern Europe.

THE administration report of the Meteorological Reporter for the North-West Provinces and Oudh for the year 1887–88, states that there are now nineteen first-class observatories and 275 rainfall stations reporting regularly to the central office. Records of rainfall and temperature are kept at numerous dispensaries all over the Jeypore territory. At the majority of the stations the old float gauge is still used, but gauges of this kind are gradually being replaced by Symons's 5-inch gauge, with improved results. Mr. Hill has under discussion a valuable series of temperature and humidity observations made at various heights above the ground. Amongst the interesting results published we may specially mention the sunshine observations at Allahabad. No less than 89 per cent. of the possible amount was recorded in November, 1887; the lowest percentage was 34·5 in August, and the mean for the year was 67·9 per cent.

THE composition of persulphide of hydrogen has at last been satisfactorily determined by Dr. Rebs of Jena. The history of this substance has been a most remarkable one; it has by turns been awarded almost every conceivable formula from H_2S_2 to H_2S_{10}. The results of Dr. Rebs' researches, however, go to show that it possesses the formula H_2S_5, first assigned to it many years ago by Berthollet, and that it is a true pentasulphide of hydrogen. It was prepared pure by the following method: A solution of soda in alcohol was saturated with sulphuretted hydrogen gas, and an equal bulk of alcoholic soda afterwards added to the sodium sulphydrate thus formed. After agitation the fluid solidified to a white crystalline mass of sodium sulphide, to which flowers of sulphur were added in the proportion necessary to form the required polysulphide of soda. The di- and tri-sulphides prepared in this manner crystallized out, but the tetra- and penta-sulphides remained in solution. They were then freed from alcohol in a current of hydrogen, and the residue dissolved in water out of which all the air had been expelled. In order to obtain persulphide of hydrogen, the solutions were poured into cylinders containing concentrated hydrochloric acid kept cool by ice. Sulphuretted hydrogen gas was immediately evolved, and an emulsion formed, which on standing became clear, and small oily drops of persulphide of hydrogen settled out and united to form an oil. After decantation of the supernatant liquor and washing with ice-cold water, the oil was eventually dried and analysed. The analyses show most conclusively that all the four polysulphides of soda, when their aqueous solutions are poured into hydrochloric acid, yield one and the same polysulphide of hydrogen, viz. the pentasulphide H_2S_5. To complete the proof the four polysulphides of potassium were similarly treated, with like result; more interesting still, Dr. Rebs shows that the sulphides of barium behave in a precisely analogous manner, forming nothing but H_2S_5. When the pentasulphides are employed there is a simple exchange of metal for hydrogen, but with the lower persulphides a decomposition of the corresponding sulphide of hydrogen first formed occurs into pentasulphide and sulphuretted hydrogen. Pentasulphide of hydrogen is a bright yellow, mobile, transparent oil, possessing an odour peculiar to itself. When dry it may be preserved in a closed tube without decomposition, but in contact with water it breaks up rapidly, with evolution of sulphuretted hydrogen and separation of sulphur.

THE tobacco-plants in the Russian Government of Bessarabia have of late years suffered greatly from disease, which has almost threatened ruin to the industry of tobacco growing. Prof. Lindemann, having been asked as a specialist to study the subject, has found three kinds of disease, the most important of which by far is a kind of consumption to which the plant is subject, caused chiefly by larvæ of the beetle *Opatrum intermedium*, Fisch. This grub attacks the underground part of the stem and the leaves. The female lays her eggs from the middle of April to that of May, and in loose ground not yet covered by the plants. The larva lives two and a half months, and the pupa stage is fourteen days. The insect does not breed till the following spring. The larva feeds at first mostly on wild plants, *Atriplex* and *Convolvulus*, but never on *Leguminosæ*. It attacks Gramineæ (maize, wheat, &c.), but only the embryo of the grain, and when germination has begun the grain is avoided. Though the time of possible attack is thus short, maize culture in Bessarabia has suffered much in this way. To protect the tobacco, Prof. Lindemann recommends sowing the fields in the end of March with mustard or rape, so that the insect at the time of egg-laying may be hindered by a thick cover of vegetation. Another insect (*Pedinus femoralis*, F.) acts just like Opatrum, but does more harm to maize than to tobacco. Prof. Lindemann further describes two minor diseases affecting the leaves, and making the tobacco unsalable. One (*thrips*) is also caused by an insect; the other (*mosaic disease*) seems to be due to some condition of the ground.

THE Indian Museum has begun to issue what promises to be a most useful series of "Notes on Economic Entomology." Two numbers, by Mr. E. C. Cotes, first assistant to the Superintendent of the Indian Museum, have been published—the first presenting a preliminary account of the wheat and rice weevil in India; the second dealing with the experimental introduction of insecticides into India, and including a short description of modern insecticides and methods of applying them.

THE new number of the "Internationales Archiv für Ethnographie" (Band I., Heft III.) contains, besides various collections of short notes, the conclusion of Herr J. Büttikofer's excellent paper on the natives of Liberia, and an account, by Herr A. Woldt, of objects of interest brought by Captain Jacobsen from certain districts of the Amoor in 1884-85, and now preserved among the treasures of the Berlin Ethnographical Museum. These objects are valuable on account of the light they throw on customs connected with Shamanism.

AN instructive paper on the osteology of Porzana Carolina (the Carolina Rail), by Dr. R. W. Schufeldt, has been republished from the *Journal of Comparative Medicine and Surgery*. As defined by the American Ornithologists' Union, the order Paludicolæ, containing the Cranes, Rails, &c., is primarily divided into two sub-orders, the (1) Grues or the true Cranes, and (2) the Ralli, containing the Rails, Coots, and Gallinules, &c. The family *Rallidæ* occur in this latter group, wherein the genus *Porzana* is well represented by the subject of Dr. Schufeldt's memoir—the common Sora or Carolina Rail. A complete account of the osteology of this ralline form has never been published, yet its skeleton contains many points of interest, to say nothing of importance when it is compared with other types. When his material better admits of it, Dr. Schufeldt proposes to thoroughly compare the anatomy of the several forms of American Cranes and Rails.

THE Cavendish Lecture, delivered at the West London Hospital by Sir William Stokes, has just been published. The subject is "The Altered Relations of Surgery to Medicine."

ACCORDING to the report of the Medical Missionary Society's Hospital in Canton for 1887, the medical class numbered twelve Chinese, of whom four were women. The students are required to pay a fee, which is fixed at twenty dollars a year for three years, over which period the course extends. They support themselves and buy their own books. Western medicine and surgery are slowly but surely advancing in China, and it is now time that schools of a high order were established. The publication of many medical books, the establishing of hospitals, in which millions of patients have been treated, the training of hundreds of students, the skill of the European physicians practising in the open ports—all tend to educate China and prepare the way for greater things.

THE Russian Statistical Committee having made minute inquiry as to the number of blind people in Russia, it appears that blindness is very unequally distributed among the different nationalities inhabiting the Empire. While there are only 8 blind people for each 10,000 Poles, 10 for as many Lithuanians and Jews, and 19 for Russians and Letts, the figures rise to 22 with the Esthonians, 35 with the Bashkirs, 41 with the Mordovians, 51 with the Tartars and Tcheremisses, 63 with the Tchuvashes, and 83 with the Votyaks. Blindness is thus much more widely spread among the Ural-Altayans, and especially among the Finnish-Mongolian stems, than among the Aryans and Semites, although the conditions of all these races, so far as poverty is concerned, are much the same. It is worthy of note that one-eighth of all cases of blindness in Russia are due to small-pox, and one-half only to direct eye diseases.

A JOINT exhibition will be made at the "Cincinnati Centennial" by the National Museum, the Smithsonian Institution, the U.S. Geological Survey, and the Bureau of Ethnology. The law providing the necessary funds was not approved until May 28, so that there has been little time for preparation; but "the Government scientific exhibits," says *Science*, "will be in Cincinnati in good season, and will constitute one of the most interesting features of the exposition." In the Department of Anthropology the National Museum will exhibit cases of objects showing the geographical distribution and physical characteristics of the races of men, and the processes and results of some of the most primitive arts. It will also exhibit a collection illustrating Biblical archæology, and a collection of remains of prehistoric man in Europe, Asia, and America. In connection with the same department the Bureau of Ethnology will have a good exhibition. It has chosen as its special subject the Pueblo of Zuñi, its arts and industries; and it will show various models of Indian mounds of the Mississippi.

THE additions to the Zoological Society's Gardens during the past week include a M[illegible] Monkey (*Cercopithecus mona* ♂) from West Africa, pre[illegible] by Miss Edith Frank; a Macaque Monkey (*Mac*[illegible] charged wi[illegible] ♂) from India, presented by Miss Chester; a Brown [illegible] the "W[illegible] *Cebus fatuellus* ♂) from Guiana, presented by Mr. Roger [illegible] Dodington; a —— Capuchin (*Cebus* ——) from Columb[illegible], presented by Mr. H. B. Whitmarsh; a Grand Eclectus (*Eclectus roratus*) from Moluccas, a Red-sided Eclectus (*Eclectus pectoralis*) from New Guinea, presented by Lt.-Col. R. Wolfe; two Corn Crakes (*Crex pratensis*) British, presented by Mr. R. B. Spalding; a Green Turtle (*Chelone viridis*) from the West Indies, presented by Baron Henry de Worms; two Hog-nosed Snakes (*Heterodon platyrhinos*), a —— Snake (*Cyclophis æstiva*), two Carolina Anolises (*Anolis carolinensis*) from North America, presented by Mr. H. E. T. Glover; two European Tree Frogs (*Hyla arborea*) European, presented by Mr. Lionel A. Williams; a Tuberculated Iguana (*Iguana tuberculata*), two Common Boas (*Boa constrictor var. divinilæqua*), a —— Snake (*Dromicus ater*) from the West Indies, presented by the West Indian Natural History Exploration Committee; two Ruffed Lemurs (*Lemur varius*) from Madagascar, a Hyacin[illegible]ine Macaw (*Ara hyacinthina*) from Northern Brazil, three Red [illegible]d Blue Macaws (*Ara macao*) from Central America, four S[illegible]ted Tinamous (*Nothura maculosa*) from Buenos Ayres, depos[illegible]; two King Crabs (*Limulus polyphemus*) from North Americ[illegible] purchased; two Mule Deer (*Cariacus macrotis*) born in the Gar[illegible]ns.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1888 *JULY* 22–28.

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on July 22

Sun rises, 4h. 12m.; souths, 12h. 6m. 11·8s.; sets, 20h. 0m.: right asc. on meridian, 8h. 8·9m.; decl. 20° 9′ N. Sidereal Time at Sunset, 16h. 4m.

Moon (Full on July 23, 6h.) rises, 19h. 39m.; souths, 23h. 53m.; sets, 4h. 10m.*: right asc. on meridian, 19h. 57·3m.; decl. 20° 25′ S.

Planet.	Rises.	Souths.	Sets.	Right asc. and declination on meridian.	
	h. m.	h. m.	h. m.	h. m.	° ′
Mercury..	3 6	10 54	18 42	6 56·0	19 10 N.
Venus.....	4 23	12 20	20 17	8 22·3	20 34 N.
Mars......	12 49	17 48	22 47	13 51·2	12 34 S.
Jupiter....	15 10	19 34	23 58	15 37·6	18 37 S.
Saturn....	4 58	12 43	20 28	8 45·4	18 43 N.
Uranus....	11 8	16 47	22 26	12 51·0	4 46 S.
Neptune..	0 11	7 58	15 45	4 0·2	18 55 N.

* Indicates that the setting is that of the following morning.

Comet Sawerthal.

July.	h.	Right Ascension. h. m.	Declination. ° ′
22	0	1 7·9	51 59 N.
26	0	1 7·3	52 38

Occultations of Stars by the Moon (visible at Greenwich).

July.	Star.	Mag.	Disap.	Reap.	Corresponding angles from vertex to right for inverted image.
			h. m.	h. m.	° °
22	o Sagittarii	4	0 42	1 15	173 235
23	20 Capricorni	6	21 35	22 46	64 269
26	74 Aquarii	6	0 57	2 11	80 308

July.	h.	
23	—	Total eclipse of Moon: first contact with penumbra 2h. 57m.: first contact with shadow 3h. 55m., shortly after which, at 4h. 10m., the Moon sets at Greenwich.
23	22	Jupiter stationary.
24	4	Venus at least distance from the Sun.
27	13	Venus in conjunction with and 0° 35′ north of Saturn.

Variable Stars.

Star.	R.A.	Decl.		
	h. m.	° ′		h. m
U Cephei	0 52·4	81 16 N.	July 25,	20 50 *m*
R Piscium	1 24·9	2 18 N.	,, 22,	*M*
W Virginis	13 20·3	2 48 S.	,, 25,	3 0 *M*
U Boötis	14 49·2	[illegible] 9 N.	,, 22,	*m*
δ Libræ	14 55·0	[illegible] 4 S.	,, 27,	0 18 *m*
V Coronæ	15 54·5	39 55 N.	,, 26,	*M*
U Ophiuchi	17 10·9	1 20 N.	,, 24,	2 50 *m*
			,, 24,	22 58 *m*
U Sagittarii	18 25·3	19 12 S.	,, 27,	1 0 *m*
β Lyræ	18 46·0	33 14 N.	,, 27,	23 0 *M*
η Aquilæ	19 46·8	0 43 N.	,, 25,	23 0 *M*
X Cygni	20 39·0	35 11 N.	,, 25,	0 0 *M*
δ Cephei	22 25·0	57 51 N.	,, 23,	2 0 *m*
R Pegasi	23 1·0	9 56 N.	,, 28,	*M*

M signifies maximum; *m* minimum.

Meteor-Showers.

	R.A.	Decl.	
	°	°	
Near δ Cassiopeiæ	20	59 N.	Very swift. Streaks.
The *Perseids*	25	53 N.	Swift. Streaks.
The *Aquarids*	340	13 S.	Max. July 28.

GEOGRAPHICAL NOTES.

THE last [illegible]ey of the Austrian Alps, we learn from the Proc. R.G.[illegible] as already led to some important, if not altogether une[illegible]ted results. Thus the Marmolata, the highest dolomite, [illegible] reduced from 11,464 feet to 11,016 feet. The Antelao comes next, reaching, according to the new Italian survey, 10,874 feet. Mr. D. Freshfield pointed out in 1875, in his "Italian Alps," that the two highest points of the Primiero group do not differ by 159 metres, as then indicated in the Government survey, but are almost equal in height. The new measurements show a difference of only 16 feet between them, and reverse the advantage. The figures are subjoined:—

	Last survey.	Old survey.	Previous Cadaster measurement.
	m.	m.	m.
Cima di Vezzana ...	3191	3061	3317
Cimon della Pala ...	3186	3220	3343

The Cima di Vezzana is therefore 10,470 feet and the Cimon della Pala 10,454 feet. The remaining peaks of the Primiero group gain or lose only a few feet by the new measurements.

MR. W. J. ARCHER, British Vice-Consul at Chiengmai, has written an interesting Report of a journey he made in his district last year. This journey extended north along the Meping River, north-east to Chiengsin on the Cambodia River, south and east to Nan on the Nam Nan, then westwards across the Meyom, by Lakhon to Chiengmai. Several maps accompany the Report, which add considerably to our knowledge of the topography of the region visited. Mr. Archer, writing of the new capital of Müang Fāng, describes the manner in which this and similar new settlements were formed in Siam. In such new colonies, as the people spread out over the districts around, other settlements were gradually formed at a distance from the capital. A large body of immigrants, or a number of families from the same locality, generally form a separate settlement, especially if they are of a different race from the original settlers; and if they settle in the capital they usually have a separate quarter allotted to themselves. This is characteristic of all the settlements in Siam, both in the larger cities and in the provinces. In Bangkok the inhabitants of the different quarters have gradually become amalgamated; but not far from the capital the colonies of former captives of war still retain their language and customs, and keep up little intercourse with their conquerors. In the northern country the separation is as complete, and the area of Chiengmai, for example, is divided into numerous quarters, each inhabited almost exclusively by people of a different race; and many of the villages in the provinces are also colonies of refugees or captives. Mr. Archer is of opinion that the country of the Thai Yai (literally "great Siamese"), or its vicinity, is the cradle of the Thai people, who thence gradually flowed southward. The Thai family has numerous divisions, differing more or less in appearance, language, and costume, though it is not difficult to trace the common type through all. The whole subject of the gradual development and modifications of the Thai race is a very interesting one from an ethnological point of view, and, Mr. Archer thinks, well worthy of research for the light it may throw on the early history of Indo-China. Mr. Archer gives many useful notes on the various hill-tribes of the country, whose distribution and characteristics deserve careful investigation. It is to be hoped he may have further opportunities of exploring the region and collecting additional information.

THE Council of the Russian Geographical Society have issued a memorandum with regard to the teaching of geography in the Universities. This memorandum will probably be taken as a basis for the impending organization of University teaching and degrees in geography in Russia. "Geography," the Council write, "being a study of the laws and associations of phenomena of the physical and organic life of the earth, it implies a serious preliminary study of natural sciences. Without a serious knowledge of the laws of physics, it is impossible to reason upon the laws dealing with the physical features of the globe. For recognizing its true place in the solar system, its figure and movements, the knowledge of astronomy and geodesy is absolutely necessary. The origin of the present features of the surface of the earth cannot be dealt with without a knowledge of geology and mineralogy. Botany and zoology are necessary for studying the laws of the distribution of organisms; while a knowledge of anatomy and physiology is necessary for the study of anthropology, phyto-geography, zoo-geography, and anthropo-geography, and so on." The experience of the German Universities having shown how difficult it is for the student to master all these subjects if he merely follows the usual lectures of the Natural Sciences Faculty, the Council express a hope that special courses, appropriate to the requirements of geographical students, may be opened in physics, astronomy and geodesy, chemistry, mineralogy and petrography, geology and the study of soils (a branch which has lately received a good deal of attention in Russia), zoology, anatomy and zootomy, physiology, history, literature, comparative philology, and the leading principles of political economy and statistics. Psychology being intrusted in Russian Universities only to Professors chosen from among the clergy, the Council urge that it should be introduced into the Natural History Faculty. As to geography proper, they advise, first, that there shall be two separate Professors for geography and anthropology, and point out the absolute impossibility of combining both sciences in one professorship. They propose, moreover, to divide the course of geography into two distinct parts, physical geography (*Erdkunde*) and special geography (*Länderkunde*). Historical geography is excluded from the programme, its contents belonging partly to history and partly to the *Länderkunde*. Although fully recognizing the difficulty of having lectures in all the above-named subjects especially appropriated to the needs of geography, the Council suggest that *privat-docents* might supply the new want. But if this is found to be impossible, they advise that the students who wish to take either geography or anthropology as their specialty should be left to select in the above-named group of sciences those subjects which would best suit them. Students might thus take any one of the three chief directions opened to the geographer—namely, that of the geologist-geographer, the biologist-geographer, or the anthropologist-geographer.

THE MULTIPLICATION AND DIVISION OF CONCRETE QUANTITIES.[1]

I HAVE recently been laying stress on the fact that the fundamental equations of mechanics and physics express relations among *quantities*, and are independent of the mode of measurement of such quantities; much as one may say that two lengths are equal without inquiring whether they are going to be measured in feet or metres; and indeed, even though one may be measured in feet and the other in metres. Such a case is, of course, very simple, but in following out the idea, and applying it to other equations, we are led to the consideration of products and quotients of concrete quantities, and it is evident that there should be some general method of interpreting such products and quotients in a reasonable and simple manner. To indicate such a method is the object of the present paper.

For example, I want to justify the following definition, and its consequences: Average velocity is proportional to the distance travelled and inversely proportional to the time taken, and is measured by the distance divided by the time, or, in symbols, $v = s \div t$. As a consequence of this, the distance travelled is equal to the average velocity multiplied by the time, or $s = vt$. The following examples will serve to illustrate what I mean:—

(i.) If a man walks 16 miles in 4 hours, his average speed is $\frac{16 \text{ miles}}{4 \text{ hours}} = 4 \times \frac{1 \text{ mile}}{1 \text{ hour}} = 4$ miles an hour, the symbol $\frac{1 \text{ mile}}{1 \text{ hour}}$ denoting a speed of a mile an hour, in accordance with the definition.

Similarly, $\frac{1 \text{ foot}}{1 \text{ second}}$, or shortly, $\frac{\text{ft.}}{\text{sec.}}$, denotes a velocity of a foot per second. The convenience of this notation is that it enables us to represent velocities algebraically, and to change from one mode of measurement to another without destroying the *equation*.

$$\text{Thus } \frac{16 \text{ miles}}{4 \text{ hours}} = \frac{4 \text{ miles}}{1 \text{ hour}} = \frac{4 \times 1760 \times 3 \text{ feet}}{60 \times 60 \text{ seconds}} = 5{\cdot}9 \frac{\text{ft.}}{\text{sec.}}$$

$= 5{\cdot}9$ feet per second.

(ii.) The distance travelled in 40 minutes by a person walking at the rate of $4\frac{1}{2}$ miles an hour $= \frac{4\frac{1}{2} \text{ miles}}{1 \text{ hour}} \times 40$ minutes $= \frac{4\frac{1}{2} \text{ miles}}{3} \times 2 = 3$ miles.

Such concrete equations are used by a considerable number of people, I believe, but I have not seen any attempt at a general method of interpreting the concrete products and quotients involved.

Now, I think I cannot do better by way of clearing the ground before us than quote what Prof. Chrystal says in his "Algebra" about multiplication and division. He begins by saying that multiplication originally signified mere abbreviation of addition; and then (on p. 12) he says:—

"Even in arithmetic the operation of multiplication is extended to cases which cannot by any stretch of language be brought under the original definition, and it becomes important to inquire what is common to the different operations thus comprehended under one symbol. The answer to this question, which has at different times greatly perplexed inquirers into the first principles of algebra, is simply that what is common is the formal laws of operation [the associative, commutative, and distributive laws]. These alone define the fundamental operations of addition, multiplication, and division, and anything further that appears in any particular case is merely a matter of some interpretation, arithmetical or other, that is given to a symbolical result, demonstrably in accordance with the laws of symbolical operation."

"*Division*, for the purposes of algebra, is best defined as the inverse operation to multiplication."

I will begin by considering instances, and then go on to the general case.

A product of a number and a concrete quantity presents no difficulty. All that is necessary is to define that the order of stating the product shall not alter its meaning—that is, that the *commutative* law shall hold—that,

e.g., 2 × 1 foot = 1 foot × 2 = 2 feet.

The *distributive* law is satisfied; thus,

2 feet + 3 feet = (2 + 3) feet
= 5 feet.

In interpreting the meaning of the product of two concrete quantities, we have to be careful that in the interpretation nothing shall violate the laws of *numerical* multiplication; *i.e.* if any numerical factors occur, they must be able to be multiplied in the ordinary way, and placed before the final concrete product, which must, of course, represent something which varies directly with both quantities.

Thus 4 feet × 2 yards must be equal to 8 × 1 foot × 1 yard.

Now a *rectangle*, whose sides are 4 feet and 2 yards, is eight times the rectangle whose sides are 1 foot and 1 yard, so that, if we define the product of two lengths as representing a rectangle whose sides are these lengths respectively, we are not violating any multiplication law as regards the numerical multipliers; and we can compare one such rectangle with any other whose sides are of different lengths, by ordinary multiplication and division among such numbers as arise, and by interpretation of the concrete products in accordance with the definition.

Thus, 4 feet × 2 yards = 8 × 1 foot × 1 yard,
= 24 × 1 foot × 1 foot,
= 24 square feet,
= 24 × 12 inches × 12 inches,
= 3456 square inches,
&c.

Here we have applied the commutative law so as to bring the numerical factors together for multiplication, and have interpreted the remaining concrete products in accordance with the definition.

The general result is that $ab = \alpha\beta \,.\, a'b'$, if $a = \alpha a'$, and $b = \beta b'$, *i.e.* a rectangle whose sides are a, b is $\alpha\beta$ times a rectangle with sides a', b', if $a = \alpha a'$, and $b = \beta b'$.

From this example I think we can see that a concrete product may properly be used to represent any quantity that varies directly as the several concrete factors, and that, being so represented, it may, by use of the ordinary rules of multiplication, be compared with any other concrete product of the same kind; that is to say, that, *generally*, $ab = \alpha\beta \,.\, a'b'$, if $a = \alpha a'$, and $b = \beta b'$, where α, β are numerical factors, and a, a' are different amounts of one kind of quantity, and b, b' of the other kind.

Similarly, a concrete quotient may be used to represent a quantity which varies directly as the concrete numerator and inversely as the concrete denominator, and may, by the ordinary rules of multiplication and division, be compared with any other quantity of the same kind.

Indeed, I may go further and assert that a concrete product or quotient (the latter including the former) MUST, if it is to have any meaning at all, represent a quantity varying directly as the concrete factors in the numerator and inversely as those in the denominator, and that the general use of such representation is for comparison of the complex quantity with a standard of the same kind. Or, generally, we may say it should be used, whenever we wish, in our work, to give as full and explicit a representation to the complex quantity as possible.

The operation of multiplying [and dividing] concretes may be separated into two parts: the *formation* of the products, and the *simplification* of them; and this latter process may be again considered in two parts: the simplification of the numerical factors, *i.e.* ordinary multiplication and division, and the simplification of the concrete factors, *i.e.* cancelling where possible, and, finally, interpretation.

[1] Paper read at the General Meeting of the Association for the Improvement of Geometrical Teaching, on January 14, 1888, by A. Lodge, Cooper's Hill, Staines.

The first part of the multiplication is the *representation* of a complex quantity which is proportional to the several factors in the numerator, and inversely proportional to those in the denominator; the second part is the comparison between the particular complex quantity and a standard of the same kind. The representation may be temporary, *i.e.* adopted for the solution of a particular problem; or it may be permanent, *i.e.* adopted throughout a whole subject.

Thus, if a, b are two lengths, the product ab is always used to represent a *rectangle* whose sides are a, b respectively; though we *might* have agreed to use it as a representation of a parallelogram with sides a, b containing an angle of (say) 60°; and of course we might find a number of things which in some particular problem might be represented by ab, but all such quantities must agree in this property, viz. that in the problem in question they shall vary jointly as a and b.

Our right to cancel among concretes may be established once for all in some such way as the following:—

Let $a = \alpha a'$, $b = \beta b'$, and therefore $ab = \alpha\beta \,.\, a'b'$, as before. Now, if we proceed to deduce a formally from the equation $ab = \alpha\beta \,.\, a'b'$, we shall get $a = \frac{\alpha\beta \,.\, a'b'}{b}$, which reduces down to its known value $\alpha a'$ if we allow b in the denominator to cancel against its equivalent $\beta b'$ in the numerator. (This cancelling is really an application of the law of association to the quotients.)

By such methods as this we can establish once for all our right to apply the formal laws of multiplication and division to concrete products and quotients, when such concrete products and quotients represent quantities varying directly as the concrete numerator and inversely as the concrete denominator; though, indeed, for that matter a very little practice in the use of such concrete representations renders one's perception of that right almost intuitive. In fact, in all cases a student would very soon perceive that the standards involved in the various equations might be treated exactly like numbers, and he would also learn from the resulting expressions $\left(e.g.\ \frac{\text{foot}}{\text{sec.}},\ \frac{\text{foot}}{(\text{sec.})^2},\ \&c.\right)$ to appreciate the meaning of the *dimensions* of quantities with a thoroughness unattainable in any other way.

All questions dealing with mixed standards, or change of standards, present no difficulty when this method is adopted.

Here is a good example of the concrete method. Two ton-masses placed a yard apart attract each other with a force equal to the weight of one-eighth of a grain. Calculate the mass of the earth in tons.

Solution. $$\frac{\text{earth} \times \frac{1}{8}\text{ grain}}{(4000\text{ miles})^2} = \frac{1\text{ ton} \times 1\text{ ton}}{(1\text{ yard})^2}$$

$$\therefore \text{mass of earth} = \frac{1\text{ ton}}{\frac{1}{8}\text{ grain}} \times \left(\frac{4000\text{ miles}}{1\text{ yard}}\right)^2 \text{ tons}$$
$$= \&c.$$

It is most important that the student should be taught to notice that physical equations can only be among quantities of the same kind, or that, if there are quantities of different kinds in the equation, then the equation is really made up of two or more independent equations which must be separately satisfied, each of these being only among quantities of the same kind. So we may consider generally that, in any equation, all the terms must represent quantities of the same kind.

But I want to call attention to the fact that merely the dimensions of a quantity do not always fix the kind of quantity. For example, the moment of a force is of the dimensions of work, and yet it is not work, and cannot exist as a term in an equation involving work terms. Again, the circular measure of an angle is not a pure number, though it is of zero dimensions as a pure number is; and that it is not a pure number is evident physically, for a moment of a force × an angle = work.

Now these are special cases of certain general laws as to direction which hold among the terms of an equation involving directed quantities, *but in which the symbols themselves do not include the idea of direction* (for I wish to confine myself strictly to ordinary algebraical equations).

The laws are: firstly, if any term is independent of direction, every term must be also independent of direction, or involve ratios between *parallel* vectors, and so by cancelling direction become independent of it.

E.g. if a body is projected with velocity V at angle α with the horizon, it reaches its greatest height in the time $\frac{V \sin \alpha}{g}$.

Here both numerator and denominator are vertical vectors, and therefore the directions cancel as they ought.

Secondly, if any term involve only one vector, the other terms must also, after such simplification of directions as possible, involve *the same* vector only.

E.g. Horizontal range of projectile $= \frac{2V^2 \sin \alpha \cos \alpha}{g}$, where $V \sin \alpha$ and g are vertical vectors, and $V \cos \alpha$ is horizontal, so that the whole expression is a horizontal vector, as it should be.

Again, if any term involve a product (or ratio) between two vectors including any angle, every term must, after such cancelling and simplification of directions as possible, also involve a product (or ratio) between two vectors including the same angle.

The most frequent cases are those where a term consists of a product of parallel, or mutually perpendicular directed quantities, in which case every term must do the same.

It is not easy to see what law holds in cases where a greater number of directed quantities occur in each term, except in the simple case where one term consists of a product of a number of parallel vectors, in which case every term must do the same.

The general law is, I believe, that if any term consists in its simplest form of a product or quotient of certain vectors, which will form a kind of solid angle, then every term must also involve an exactly *similar* solid angle of vectors. However, I have not followed this out, as it does not seem likely to be a useful test in its general form.

The following are simple examples of some of the above laws:

$$\left.\begin{aligned} b &= a \cos C + c \cos A \\ a^2 &= b^2 + c^2 - 2bc \cos A \end{aligned}\right\} \text{ in a triangle;}$$

$$y = mx + c;$$

$$\sin (A + B) = \sin A \cos B + \cos A \sin B.$$

This last example should be considered in connection with the ordinary geometrical proof, where it will be seen that each term on the right is a ratio between lines inclined to each other at the angle 90° – (A + B), just as the left-hand side is.

An angle is the ratio between the arc and radius of a circle, and if it multiplies a radius, changes it into an arc. Thus, if by applying a force P at the end of an arm a, a body is turned through a small angle θ, the work done is $Pa\theta$; *i.e.* the product of P into the arc through which it has been acting, which is a product of *parallel* vectors, as it must be besides having to be of right dimensions if it is to represent work. This expression is also the product of the moment of the force into the small angle turned through, so that, if we wish to connect the moment of a force with work, we must say:—

The moment = the work *per radian* which can be done,

$$\text{or simply, moment} = \frac{\text{work done}}{\text{angle turned through}}.$$

Now I do not wish to insist that in dealing *practically* with mechanical problems it is necessary always to include the standards as well as the numerical multipliers in the equations, for it would be an intolerable nuisance to have to do so. In complicated cases, however, I think the student should test the dimensions of each term in his equation, so as to avoid gross mistakes. But it is in trying to *understand* the fundamental equations in any subject that it appears to me important to express particular examples of them as fully as possible.

For practical purposes any numerical equations we may desire may be deduced from the fundamental equations.

For example, the connection between the height (h) of an observer above the sea with the distance (d) of his horizon, is $d^2 = 2Rh$, where R is the radius of the earth; and we can deduce from this the numerical relation between the height in *feet*, and the distance of vision in *miles*. For if f be the number of feet in h, and m the number of miles in d, so that $h = f$ feet, and $d = m$ miles, the equation becomes

$$(m\text{ miles})^2 = 2R \times f\text{ feet,}$$
$$= 8000\text{ miles} \times f\text{ feet;}$$
$$\therefore f = m^2 \frac{(\text{miles})^2}{8000\text{ miles} \times 1\text{ foot}} = \frac{5280}{8000} m^2,$$
$$= \tfrac{2}{3} m^2 \text{ approximately;}$$

i.e. the observer's height in feet = $\frac{2}{3}$ of the square of the distance of his view in miles.

This is a strictly numerical equation, deduced for practical purposes from the concrete equation $d^2 = 2Rh$.

It cannot, I think, be too clearly impressed on the student that, when any quantity is expressed by a number, that number is the *ratio* of the quantity to some standard of the same kind.

To take the preceding example, f is the number of feet in the height h.

$$i.e. \quad h = f \text{ feet},$$

$$\therefore f = \frac{h}{1 \text{ foot}} = \text{the } ratio \text{ of } h \text{ to } 1 \text{ foot}.$$

$$\text{Similarly } m = \frac{d}{1 \text{ mile}} = \text{the } ratio \text{ of } d \text{ to } 1 \text{ mile}.$$

So that the full expression for the relation $f = \frac{3}{2}m^2$ is :—

$$\frac{\text{height}}{1 \text{ foot}} = \tfrac{3}{2} \text{ of} \left[\frac{\text{distance}}{1 \text{ mile}}\right]^2.$$

My position, therefore, as regards numerical equations, is this: That the numbers which appear are only short methods of stating pure ratios, and that such short methods are eminently useful in dealing with practical problems, but do not help a student to grasp the fundamental principles of a subject.

There is another simple way in which numerical equations can be deduced from the fundamental ones; viz. by so choosing the standards of measurement that every term may be expressed in terms of the same standard, which may then be omitted, leaving only a relation among the numerical coefficients of that standard.

To enable this to be done, all the standards of subsidiary quantities are so chosen that, when expressed in terms of certain primary standards, their coefficients shall be unity. When this is systematically done, all the standards are usually called *units*, apparently because if you arbitrarily put *unity* for each primary standard, the subsidiary ones will become equal to unity also.

For example, if a foot and a second are chosen units of length and time, a foot per second is the unit of velocity. For, the full expression for a foot per second is $\frac{1 \text{ foot}}{1 \text{ sec.}}$; and if you put 1 foot $= 1$, and 1 sec. $= 1$, the fraction $\frac{1 \text{ foot}}{1 \text{ sec.}}$ becomes equal to 1 also.

This plan certainly enables the working numerical equations to be very easily deduced from the fundamental ones, with which indeed they thus become identical in form, but there is great danger lest this fact should make us lose sight of the important fact that they are only special deductions from the higher kind of equation—from the true fundamental equations which exist among the quantities themselves.

DISCOVERY OF ELEPHAS PRIMIGENIUS *ASSOCIATED WITH FLINT IMPLEMENTS AT SOUTHALL.*

A PAPER with the above title was lately read by Mr. J. Allen Brown before the Geologists' Association. It is of more than ordinary interest to geologists since an attempt has lately been made to show that the mammoth became suddenly extinct by the action of a vast flood seemingly universal in its operation, due to some convulsion or cataclysm, which also changed the climate of Northern Europe.

During last year some important drainage works were carried out at Southall, and sections were exposed in the Windmill Lane, a road running from Greenford, through Hanwell, across the Great Western Railway to Woodlake, skirting Osterley Park, as well as in Norwood Lane, leading from Windmill Lane, south-westward.

The remains of the mammoth were discovered in Norwood Lane at the 88-foot contour, about 550 yards from its junction with the Windmill Lane. They were embedded in sandy loam, underlying evenly stratified sandy gravel, with a thin deposit of brick earth, about 1 foot in thickness, surmounting the gravel—in all, about 13 feet above the fossils. The tusks were found curving across the shore or excavation, attached to the skull, parts of which, with the leg-bones, teeth, &c., were exhumed, other bones being seen embedded in one side of the cutting. Probably the entire skeleton might have been removed if the excavation could have been extended, and if there had been appliances at hand for removing the fossils, which were in a soft pulpy condition.

The author obtained some of the bones in a fragmentary state, including parts of the fore-limbs and jaw, with portions of the tusks as well as two of the three teeth found, which were much better preserved. The remains were quite unrolled, and the joints and articulations of the leg-bones and the teeth were unabraded. There can hardly be a doubt, from the report of the workmen, that the bones of the fore-part of the elephant, if not of the entire skeleton, were in juxtaposition.

Several implements were found in Norwood Lane, in close proximity to the remains, and a well-formed spear-head, nearly 5 inches in length, of exactly the same shape as the spear-heads of obsidian until recently in use among the natives of the Admiralty Islands, and other savages, was discovered in actual contact with the bones; smaller spear-head flakes, less symmetrically worked, were also found at this spot. They are formed for easy insertion into the shafts by thinning out the butt ends, similar to those found abundantly by the author at the workshop floor, Acton, and described by him in his recently published work, "Palæolithic Man in North-West Middlesex." Among the implements found at this spot are an unusually fine specimen of the St. Acheul or pointed type, 8 inches long, of rich ochreous colour and unabraded, and a well-formed lustrous thick oval implement pointed at one extremity, rounded at the other, about 5 inches in length, also unrolled.

From the adjacent excavations in the Windmill Road several good specimens of Palæolithic work were also obtained, including two dagger implements, with heavy unworked butts, and incurved sides converging to a long point; these were evidently intended to be used in the hand without hafting. Also an instrument characteristic of the older river drift, convex on one side, and slightly concave on the other near the point, and partly worked at the butt. With these were two rude choppers or axes, two points of implements with old surfaces of fracture, a shaft-smoother or spoke-shave, and several flakes.

It is remarkable that most of the principal types of flint implements which characterize the oldest river-drift deposits are represented in this collection from the vicinity of the remains of the elephant.

Mr. J. Allen Brown accounts for the deposit of fossils and associated human relics at this locality by the fact that the underlying Eocene bed rises to within 2 or 3 feet of the surface a few yards west of the spot where the bones and implements were found, while towards the Uxbridge Road and upper part of the Windmill Lane the drift deposits thicken, until at no great distance they have a thickness of 14 to 17 feet. Thus the river drift rapidly thins out, and the upward slope of the London Clay reaches nearly to the surface at about the 90-foot contour. As the level at which the fossils were found (13 feet from the surface) would represent the extent of the erosion and in-filling of the valley which had taken place, it is probable that the higher ground formed by the up-slope of the London Clay then formed the banks of the ancient river; or if another thick bed of drift should be found still further west in a depression of the Tertiary bed such as often occurs, the intervening higher ground would form an island in the stream. In either case a habitable land surface would be formed with shallow tranquil water near the banks, not impinged upon by the current, which afterwards set in the direction of this spot, as shown by the coarser slatified gravel above the loamy bed and remains.

The author is thus led to the conclusion either that the carcass of the elephant drifted into the shallow tranquil water near the bank, or else, as seems more probable from the presence of so many weapons near the spot, including the spear-head found with the remains, that the animal was pursued into the shallow water by the Palæolithic hunters and there became bogged. Whatever hypothesis may be accepted, there is no evidence of any greater flood or inundation than would often occur, under the severe climatal conditions which prevailed during the long period that intervened between the formation of the higher brenches of river drift and that of the mid terrace, only 25 to 30 feet above the present river, in which the remains of the mammoth and the extinct Quaternary Mammalia are more frequently met with under similar conditions. Nor does there appear to be any more reason for ascribing the extinction of the great Quaternary Pachyderms to a sudden catastrophe or cataclysm than there is for the extinction of some other Pleistocene animals, such as the great Irish elk, which lived on into, or nearly into, historic times. The difficulty involved in this hypothesis is still further increased by the fact that other animals, such as the reindeer and others of northern habit, as well as southern forms like the hippopotamus, were not utterly destroyed with their contemporaries by the same cause, but merely migrated to regions more suited to them, as the climate and other conditions of this country changed.

Exhibits.—Bones, teeth, and part of the tusks of mammoth, and associated flint implements from Southall. A flint implement from the lacustrine (?) bed at the Mount, Ealing (190 to 200 O.D.) (See the author's paper, Proceedings Geologists' Association, vol. x. No. 4). A flint apparently worked by man from the Weybourn Crag, beneath the "Forest bed" near Cromer. A Palæolithic scraper found on the beach near Cromer, &c.

THE POISONOUS SNAKES OF THE BOMBAY PRESIDENCY.

AT a recent meeting of the Bombay Natural History Society, a paper was read by the Honorary Secretary, Mr. H. M. Phipson, on the "Poisonous Snakes of the Bombay Presidency." He produced for inspection specimens of the following poisonous snakes, all of them having been killed in the Presidency of Bombay.

Colubrine.—(1) *Ophiophagus elaps*; (2) *Naga tripudians*; (3) *Bungarus arcuatus*; (4) *Callophis trimaculatus*; (5) *Callophis nigrescens.*

Viperine.—(6) *Daboia elegans*; (7) *Echis carinata*; (8) *Trimeresurus anamallenis*; (9) *Hypnale nepa.*

With regard to the first species, the *Ophiophagus elaps*, it is perhaps the largest poisonous snake in the world, sometimes measuring over 15 feet. It is also called the "king cobra" or "hamadryad," and is not very common, though widely diffused, being found in the Andamans, the Philippines, Borneo, Java, and Sumatra. On account of expanding a "hood," it is frequently mistaken for the cobra, but the head-shields of the hamadryad differ very much from those of the cobra. The second species, *Naga tripudians*, or cobra, is found all over India, and up to the height of 8000 feet in the Himalayas. There are many varieties, differing in colour and marking, to which the natives give different names, thinking them distinct species; but in such matters the native knowledge is not very extensive. Thus they believe that all the hooded cobras are females, and that the males are harmless. What they call the male is in reality only the common Indian rat snake (*Ptyas mucosus*). They also state that the rat snake is proof against the poison of the cobra. But this is not the case. Last year the young ones hatched in the Society's rooms attacked a small Malay python put into their cage, when they were only a few days old, and bit at it viciously, and the python died in a few hours after its removal to another cage. Once a year, during the rainy season, the cobra lays from twelve to twenty eggs. In one specimen shown by Mr. Phipson, the young one is seen just as it is emerging from the egg. The tooth with which it cuts its way out is shed as soon as it has served its purpose. When born, the young cobras measured about 7½ inches long, and were very fat; but at the end of a few months they were about 9 inches in length, but had lost all their plumpness. It is very remarkable that the original nutriment got out of the egg should be able to sustain them so long. On account of its timidity and the great ease with which it can be tamed, it is the only snake with which the snake-charmers will have anything to do. By attracting its attention with one hand, it may be easily seized round the body with the other; and so long as the hand or any other object is kept moving before its eyes it will never turn to bite the hand that holds it. This is the simple fact the knowledge of which the charmers turn to such advantage in their well-known performances. The snake is taken from its basket, and a slight stroke across the back brings it at once into a defensive attitude. The constant motion of the musical instrument before the snake keeps it watchful and erect, and not the music produced. As a matter of fact, snakes have no external ears, and it is extremely doubtful whether the cobra hears the music at all. The charmers say that the adder of the East, the *Daboia*, has no ear for music, because they cannot operate on it as they do on the cobra. It is rather interesting to note that this has been the belief since David's time at least—"like the deaf adder that stoppeth her ear; which will not hearken to the voice of charmers." (3) The krait (*Bungarus arcuatus*) is an exceedingly poisonous snake, and is quite common in nearly every part of India. One specimen taken in the Bombay Presidency contained a "brown tree snake" (*Dipsas gokool*) and in another specimen was found a *Ptyas mucosus*, thus showing that this species eats snakes. The common *Lycodon aulicus*, one of the non-poisonous snakes, is very much like the krait, but they can be distinguished by the presence in the krait of large hexagonal scales down the centre of the back. (4) The *Callophis trimaculatus* has no popular name. It is undoubtedly poisonous, and lives on other snakes, very likely the Calamariæ. (5) *Callophis nigrescens*, which grows to about 4 feet in length, is black in the upper parts and red in the lower.

(6) The first class of the Viperine snakes is the *Daboia elegans* called by Europeans in India the Chain Viper and in Ceylon the Tic Polonga. The fangs are very long, and for this reason, together with its fierceness, it is the most dreaded snake in India. Its poison acts differently from that of the cobra. Its tenacity of life is really wonderful, it having been known to live for a whole year without food. The length of this snake rarely exceeds 5 feet. (7) The *Echis carinata* and the last-named class are the only true vipers in India. The harmless "brown tree snake" (*Dipsas gokool*) is frequently confused with the *Echis carinata*, but they are easily distinguished by the scales on the head of the latter, while the *Dipsas gokool* has plates or shields. (8) The green tree viper (*Trimeresurus anamallensis*) is one of the family of Crotalidæ or pit vipers, so named from the pit or cavity beneath the eye and the nostril, of which family the terrible rattlesnake of America is a member. In India there are eight species of Trimeresuri, but up to the present only one has been found in Bombay, though it has been stated that another species, *T. strigatus* has been seen far up the country. (9) The head-quarters of the *Hypnale nepa*, or Carawala, are in Ceylon, but it is commonly found along the Malabar coast.

These classes include all the poisonous land-snakes. All the true sea-snakes are poisonous, and of these, amongst others, the following are in the Bombay collection: *Hydrophis diadema, Hydrophis robusta, Hydrophis curta, Hydrophis aurifasciatus, Hydrophis Phipsoni, Hydrophis Guntheri, Hydrophis Lindsayi, Hydrophis chloris, Enrhydrina bengalensis, Pelamis bicolor.*

SCIENTIFIC SERIALS.

Rendiconti del Reale Instituto Lombardo, May.—Foraminifera of Mount S. Colombano Lodigiano, by Dr. Ernesto Mariani. A classified list is given of these organisms, collected chiefly by Profs. Maggi and Balsamo Cuvelli in the district stretching from the right bank of the Lambro to within a few miles of the Po. The prevalence of Miliolidæ and allied forms shows that this fauna, which mostly still survives in the surrounding seas, flourished in the warm shallow waters which at a remote epoch flooded the plains of Lombardy.—On the use of the lucimeter in agriculture, by Prof. Giovanni Cantoni. The author's recent experiments with this instrument, first designed by Bellani, show that it is calculated to render great service to husbandry in combination with the thermometer and psycrometer.—Alberto Brambilla continues his paper on a certain class of algebraic surfaces; and Prof. A. Scarenzio has some remarks on the therapeutic properties of the arsenical thermal waters of Acquarossa, near Biasca, on the old St. Gothard road in the Canton of Ticino.

June 7.—On the normal curves of genus p of various spaces, by Prof. E. Bertini. Clifford's fundamental theorem is here established by a more synthetic method than any hitherto published demonstrations. The theorem itself (Philosophic Transactions, 1878, p. 681) is here announced in the following modified form:—A curve of genus p and order $n > 2p - 2$ cannot belong to a space of more than $n - p$ dimensions.—On the proposed sanitary legislation for Italy, by D. C. Zucchi. A calculation is made that by the adoption of such measures as are enforced by the Local Government Boards in Great Britain, the average mortality of the population might be reduced from over 27 to under 20 per thousand. This is shown to be equivalent to the rescue of 100,000 lives, whose labour for 300 working days represents an annual sum of nearly £5,000,000 at present lost to the nation.—Meteorological observations made at the Royal Observatory of Brera, Milan, for the month of May.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 14.—"The Minimum-point of Change of Potential of a Voltaic Couple." By Dr. G. Gore, F.R.S.

In this communication is described the following very simple method of detecting the influence of the minimum proportion of chlorine or other soluble substance, &c., upon the electromotive force of a voltaic couple (see NATURE, vol. xxxviii. p. 117).

Take a voltaic couple, composed of an unamalgamated strip of zinc or magnesium (the latter is usually the most sensitive), and a small sheet of platinum, immersed in distilled water; balance its electric potential through an ordinary galvanometer of about 100 ohms resistance by that of a precisely similar couple composed of portions of the same specimens of the same metals, immersed the same moment as the other pair in a separate quantity of the same water; and gradually add to one of the two cells sufficiently small and known quantities of an adequately weak solution of known strength in a portion of the same water, of the substance to be used, until the balance is upset, and take note of the proportions of the substance and of the water then contained in that cell. In the present experiments a magnesium platinum couple was employed.

The minimum proportions required with several substances were as follows: potassic chloride, between 1 part in 3875 and 4650 parts of water; potassic chlorate, between 1 in 4650 and 5166; hydrochloric acid, between 1 in 516,666 and 664,285; and with chlorine between 1 in 15,656,500,000 and 19,565,210,000.

The proportion required of each different substance is dependent upon very simple conditions, viz. unchanged composition of the voltaic couple, a uniform temperature, and employing the same galvanometer. The apparently constant numbers thus obtained may probably be used as tests of the purity or of the uniformity of composition of the dissolved substances.

The "minimum-point" varies with—(1) the chemical composition of the liquid; (2) the kind of positive metal; (3) to a less degree with the kind of negative metal; (4) the temperature at the surface of the positive metal, and at that of the negative one; and (5) with the kind of galvanometer employed.

The order of the degree of sensitiveness is manifestly related to that of the degree of free chemical energy of the liquid; also to the atomic and molecular weights of the dissolved substances, and to the ordinary chemical groups of halogens. The greater the degree of free chemical energy of the dissolved substance, and the greater its action upon the positive metal, the smaller the proportion of it required to change the potential.

As the "minimum point" of a chemically active substance dissolved in water is usually much altered by adding almost any soluble substance to the mixture, measurements of that point in a number of liquids at a given temperature with the same voltaic pair and galvanometer will probably throw some light upon the degree of chemical freedom of substances dissolved in water.

"On the Change of Potential of a Voltaic Couple by Variation of Strength of its Liquid." By Dr. G. Gore, F.R.S.

This paper contains a series of tables of measurements of the electromotive forces of a voltaic couple composed of unamalgamated zinc and platinum in distilled water, and in aqueous solutions of different strengths of the following substances: potassic chlorate, potassic chloride, hydrochloric acid, and bromine. The measurements were made by balancing the potential of the couple by that of a suitable thermo-electric pile (Proc. Birm. Phil. Soc. vol. iv. p. 130) through an ordinary astatic galvanometer of about 100 ohms resistance.

The following are the minimum proportions of those substances required to change the potential of the couple in water: potassic chlorate, between 1 in 221 and 258 parts of water; potassic chloride, between 1 in 695,067 and 1,390,134; hydrochloric acid, between 1 in 9,300,000 and 9,388,185; and of bromine, between 1 in 77,500,000 and 84,545,000 parts.

With each of these substances a gradual and uniform increase of strength of the solution from the weakest up to a saturated one was attended by a more or less irregular change of electromotive force.

By plotting the quantities of dissolved substance as ordinates to the electromotive forces as abscissæ, each substance yielded a different curve of variation of electromotive force by uniformly changing the strength of its solution, and the curve was characteristic of the substance. As the least addition of a foreign soluble substance greatly changed the "minimum-point," and altered the curve of variation of potential, both the curve and the minimum proportion of a substance required to upset the balance of the couple in water may probably be used as tests of the chemical composition of the substance, and as means of examining its state of combination when dissolved. By varying the strength of the solution at each of the metals separately, a curve of change of potential was obtained for each positive metal, but not for every negative one.

"Influence of the Chemical Energy of Electrolytes upon the Minimum-point and Change of Potential of a Voltaic Couple in Water." By Dr. G. Gore, F.R.S.

By means of a zinc-platinum voltaic couple in distilled water, with its electromotive force balanced by that of a suitable thermo-electric pile[1] (Birm. Phil. Soc. Proc. vol. iv. p. 130), the effect of several groups of chemical substances upon the potential of the couple was examined. Measurements were made of the electromotive forces of a series of strengths of solution of each substance, and the results are given in a series of tables.

The minimum proportions of substance required to change the potential of the couple in water were as follows:—

Potassic iodate,	between	1	in	443	and	494
,, bromate	,,	1	,,	344	,,	384
,, chlorate	,,	1	,,	221	,,	258
,, iodide	,,	1	,,	15,500	,,	17,222
,, bromide	,,	1	,,	66,428	,,	67,391
,, chloride	,,	1	,,	695,067	,,	704,540
Iodine . . .	,,	1	,,	3,100,000	,,	3,521,970
Bromine . . .	,,	1	,,	77,500,000	,,	84,545,000
Chlorine . . .	,,	1	,,	1,264,000,000	,,	1,300,000,000

On comparing these numbers we find that the proportion of substance required to upset the voltaic balance was largest with the oxygen salts, intermediate with the haloid ones, and least with the free elementary halogens. It was smaller the greater the degree of chemical energy of the substance; thus it was about 400 times less with chlorine than with iodine. And it was smaller the greater the degree of freedom to exert that energy; thus it was about 5,416,000 times less with free chlorine than with potassic chlorate, or 1,570,000 times less than with the combined chlorine of the chlorate, and about 185 times smaller than with potassic chloride, or 88 times less than with the combined chlorine of that salt.

The order or curve of variation of potential by uniform increase of strength of the solution was different with each substance, and was apparently characteristic of the body in each case. A great number of such representative curves might be obtained with a zinc platinum or other voltaic couple in different electrolytes.

June 21.—"Further Researches on the Physiology of the Invertebrata." By A. B. Griffiths, Ph.D., F.R.S. (Edin.), F.C.S. (Lond. and Paris), Principal and Lecturer on Chemistry and Biology, School of Science, Lincoln; Member of the Physico-Chemical Society of St. Petersburg. Communicated by Sir Richard Owen, K.C.B., F.R.S.

I. *The Renal Organs of the Asteridea.*

The digestive apparatus of *Uraster rubens* (one of the Asteridea) is briefly described as follows:—The capacious mouth, found upon the oral side, leads into a short œsophagus, which opens into a wider sacculated stomach with thin distensible walls. There are five large stomach sacs; each of these is situated in radial position and passes into the base of the corresponding ray. Each sac or pouch is kept in its place by two retractor muscles fixed to the median ridge of the ray, which lies between the two ampullæ or water-sacs. Passing towards the aboral side, the stomach forms the well-known pentagonal "pyloric sac." The pyloric sac gives off five radial ducts, each of which divides into two tubules bearing a number of lateral *pancreatic* follicles, whose secretions are poured into the pyloric sac and intestine. The author has proved the nature of this secretion to be similar to the pancreatic fluid of the Vertebrata (Edinburgh Roy. Soc. Proc., No. 125, p. 120). Recently, the secretion found in the five pouches of the stomach (of *Uraster*) has been submitted to a careful chemical and microscopical examination. With a quantity of the secretion uric acid crystals were extracted by the same methods as described in his previous papers (Proc. Roy. Soc., vol. xlii. p. 392, vol. xxxviii. p. 187).

The tests proved the entire absence of urea in the secretion under examination. No guanin or calcium phosphate could be detected in the secretion, although the author has found the latter compound as an ingredient in the renal secretions of the Cephalopoda and the Lamellibranchiata (Edinburgh Roy. Soc. Proc., vol. xiv. p. 230).

[1] This instrument is manufactured by Messrs. Nalder Bros., Horseferry Road, Westminster.

From this investigation, the isolation of uric acid proves the renal function of the five pouches of the stomach of the Asteridea. These pouches are the homologues of the organs of *Bojanus* and nephridia in the Mollusca, the green glands of the Crustacea, and the segmental organs of worms.

II. *The Salivary Glands of* Sepia officinalis *and* Patella vulgata.

The author has already made a complete study of the nephridia and the so-called "livers" in both these forms of the Invertebrata (see the memoirs, *loc. cit.*). Since then he has studied the chemico-physiological reactions of the secretion produced by the salivary glands of the cuttle-fish and the limpet; these organisms representing two important orders of the Mollusca.

1. *Sepia officinalis.*

There are two pairs of salivary glands in *Sepia officinalis*. The posterior pair, which are the largest, lie on either side of the œsophagus. The secretion of the posterior glands is poured into the œsophagus, while the secretion of the smaller anterior pair of glands passes directly into the buccal cavity. This secretion was tested by similar reactions to those described in a former paper (Edinburgh Roy. Soc. Proc., vol. xiv. p. 230) and with similar results.

There is much in favour of the supposition that the *diastatic ferment* found in these secretions is produced as the result of the action of nerve-fibres (from the inferior buccal ganglion) upon the protoplasm of the epithelium cells of the glands.

The author intends to examine various organs in other genera and species of the Decapoda; especially those inhabiting the Japanese seas.

2. *Patella vulgata.*

The two salivary glands of Patella are well-marked and situated anteriorly to the pharynx, lying beneath the pericardium on one side, and the renal and anal papillæ on the other. They are of a yellowish-brown colour and give off four ducts. The secretion of these glands was examined by the same method applied to the salivary glands of *Sepia officinalis*, and with similar results.

The following table represents the constituents found in the salivary secretions of the two orders of the Mollusca aleady investigated:—

	Cephalopoda.	Gasteropoda.	
	(*a*) Dibranchiata.	(*a*) Pulmogasteropoda.[1]	(*b*) Branchiogasteropoda.
Soluble diastatic ferment	present	present	present
Mucin	present	...	present
Sulphocyanates	present	?	present
Calcium phosphate	present	?	present

From these investigations, the salivary glands of the Cephalopoda and Gasteropoda are similar in physiological function to the salivary glands of the Vertebrata.

III. *The "Liver" of* Carcinus mœnas.

The "liver" of *Carcinus mœnas* consists of two large glands on each side of the stomach, and extending the whole length of the cephalothorax. These organs are of a yellow colour, and consist of numerous cæcal tubes arranged in tufts which are easily seen in a dissection beneath the surface of water.

The secretion of the so-called "liver" of *Carcinus mœnas*, when freshly killed, gives an acid reaction.

From the reactions detailed in the paper the conclusion to be drawn is that the so-called "liver" of *Carcinus mœnas* is pancreatic in function, *i.e.* its secretion is more like the secretions of the pancreas of the Vertebrata than those of a true liver.

Some biologists look upon the vertebrate liver, pancreas, and salivary glands as differentiated bodies of an original pancreas of the Invertebrata. But have not very many forms of the lower animals similar salivary glands to those found in the Vertebrata? And is not the so-called "liver" of the Invertebrata a true pancreas capable of producing the same chemical and physiological reactions as the pancreas of higher forms?

[1] Edinburgh Proc. Roy. Soc., vol. xiv. p. 236.

Physical Society, June 23.—Prof. Reinold, F.R.S., President, in the chair.—The following communications were read:—The photometry of colour, by Captain Abney, F.R.S. This relates to the measurement of light reflected from coloured surfaces and pigments as compared with the quantity reflected from white or black. The apparatus used in the investigation consisted of a spectroscope and camera similar to those used by the author for the production of a patch of monochromatic light, and a small shadow photometer served for the measurement. The screen was made of two parts—one the colour to be tested, and the other white or black according to the standard being used; and the stick was arranged so that the shadows fell near the junction of the two parts. Light reflected from the surface of the first glass prism served to illuminate one shadow; and for the other, monochromatic light of any desired colour could be used. The intensities were adjusted to equality by cutting off more or less of the stronger light by means of a revolving wheel with adjustable sectors, the opening of the sectors being a measure of the luminosity of the pigment. In another arrangement a double-image prism was used to separate the spectrum into two parts. Monochromatic light from one part passed direct to the screen through sectors in a rotating wheel, and monochromatic light from the other spectrum was reflected on the screen at a sufficient azimuth to give a separate shadow, by means of two total reflection prisms. The losses by reflection were allowed for by observing the position of the adjustable sectors required to give equal intensities on a white screen. From the results obtained "colour curves" can be plotted for different pigments, &c., and templates constructed which, when rotated in the path of a spectrum, reproduce the corresponding colour. Carmine, sky-blue, and gold were thus reproduced. By means of templates constructed from "colour curves" any colour may be reproduced at any future time. In course of the experiments many interesting observations on colour-blindness have been obtained by the author and General Festing, some of which were described. A question was asked as to whether it was possible to reproduce any given colour, for no two arc lights could be expected to give exactly equal intensities in all parts of the spectrum. Dr. Thompson requested information regarding the effect of absorption by the different thicknesses of the prism through which the light passed, and thought the results obtained might be different if prisms of other materials were used. The fact mentioned in the paper as to the sky being greenish is well known to artists, who usually mix cobalt blue with yellow to produce the required tint. Dr. Thompson also reminded the members of an experiment he brought before the Society some years ago, in which grass seen through a solution of permanganate of potash appears bright crimson when compared with red colours seen through the same solution. In reply, Captain Abney said that colours could be imitated whatever the source used to produce the spectrum, for the resulting colour is the same as that seen when the "original" is viewed by light from that source. Regarding absorption, &c., by the prism, he did not think any appreciable difference was produced, for the results obtained when using the recomposed spectrum as white light were the same as those got by using light reflected from the surface of the first prism. In conclusion, he directed the attention of physicists to Lord Rayleigh's papers on sky colours, &c., published in the *Phil. Mag.*, which would well repay very careful study.—Note on continuous current transformers, by Prof. S. P. Thompson. Two classes of transformers are considered, viz. *motor-generators* and *commuting transformers*, in which a two-circuit armature is fixed in a revolving magnetic field. Such a field may be produced by using a fixed gramme ring as the field-magnet, and rotating the brushes round its commutator. The formulæ obtained apply equally to both classes. If c_1 c_2 be the numbers of primary and secondary wires on outside of armature; E_1 E_2, e_1 e_2, i_1 i_2, r_1 r_2, the E.M.F., potential difference at terminals, currents, and resistances of primary and secondary respectively, then it is shown that $e_2 = ke_1 - (r_2 + k^2r_1)i$, where $k = \frac{c_2}{c_1}$, which is called the "co-efficient of transformation." Thus the potential difference is the same as if the dynamo part had its resistance increased by k^2r_1. As the currents in the primary and secondary are in opposite directions, the effective self-induction will be very small, hence such machines can be run with little or no sparking. In a previous paper by the same author, similar properties as regards self-induction and resistance were shown to exist in alternating current transformers. From the above equation it is evident that a motor-generator cannot be made to give constant potential when supplied at constant potential except when the internal resistances are very small ; but by over-compounding the distributing dynamo the desired result may be obtained. Mr. Kapp agreed with the author as regards motor-generators running with little sparking, but thought the great difficulty in using them commercially would be in preserving the insulation between the circuits, if anything like 2000 volts were used in the primary. He also mentioned the method of producing a rotating field by alternating currents, recently described by Prof. Ferraris and Mr. Tesla, and thought it would be preferable to the one devised by the author of the paper. In reply, Dr. Thompson said that insulation could be easily maintained between the core and windings of brush armatures, and saw no reason why it should present very serious difficulties in continuous current transformers.—On an optical model, by Prof. A. W. Rücker, F.R.S. The model exhibited and described is to illustrate the character of the vibrations in a crystal cut parallel to the axis, when plane-polarized light is incident upon it. A rectangular glass box represents the crystal, and glass plates placed at short distances from each end imitate crossed Nicols. A rod, carrying coloured circular and elliptical rings and straight bars, passes along the axis of the box. These rings are intended to indicate the character of the vibration at the different points at which they are placed. The length of the crystal is supposed to be such that plane-polarized red rays emerge plane-polarized in the initial plane after being successively plane, elliptical, circular, elliptical plane, elliptical circular, elliptical and plane-polarized within the crystal. All the light is quenched by the analysing Nicol. Supposing light of greater frequency (say green) to be used, another rod with green ellipses, &c., is placed in the box, and illustrates that such light emerges elliptically polarized, one component only of which is stopped by the analyzer. This shows how plane-polarized white light, when passed through crystals placed betwen Nicols, may become coloured.—On a new barometer, by Mr. T. H. Blakesley. A uniform glass tube is sealed at one end and a thread of mercury introduced, inclosing a quantity of air. An observation is taken by noting the volumes, A and B, of the inclosed air (as indicated by the divisions on the scale) when the tube is placed vertically with its closed and open ends upward respectively. The height, H, of the barometer is given by the formula $H = \frac{A + B}{A - B} l$, where l is the length of the mercury column in the tube. For convenience, l is made 10 inches. The whole instrument is very portable, weighing only 6 ounces, and measuring about 18 inches long.– In the absence of the author, a paper on the existence of an undulatory movement accompanying the electric spark, by Dr. Ernest H. Cook, was taken as read. When sparks pass between two points placed above a plate on which some powdered substance has been scattered, the particles arrange themselves in circular lines approximately concentric with the projection of the middle line joining the two points. The proximity of the lines is found to be very nearly constant for the same powder, independent of the intensity of the spark used, or the material of the plate. Different powders give different numbers of lines per inch, and mixtures, numbers between those corresponding to their constituents. A great number of substances have been tried, giving numbers between forty and eighty-eight per inch. These extreme numbers were obtained for chalk and silica respectively. The author has found no satisfactory hypothesis by which to explain the results. A number of photographs accompany the paper, showing the character of the figures produced. At the meeting, an apparatus made by the late Dr. Guthrie was exhibited, with which similar figures to those described in the paper could be obtained. It consists of a shallow elliptical dish covered by a glass plate. Sparks are passed between two small knots across one focus, and powder, sprinkled on the bottom, forms into circles about the other focus.

Anthropological Institute, June 26.—Francis Galton, F.R.S., President, in the chair.—Mr. Arthur S. Burr exhibited a collection of pottery and other objects from recent excavations in New Mexico.—Mr. H. O. Forbes exhibited a series of photographs taken by him in New Guinea.—A paper on the Nicobar Islanders, by Mr. E. H. Man, was read. Mr. Man has been resident at the Nicobars for periods amounting in all to about 7 years, viz., 1871–88 ; during that time he has prepared a vocabulary containing 6000–7000 words, and he has thus been in a position readily to make inquiries from the natives on the various points of ethnological interest connected with their constitution and their culture, and to substantiate from a variety of independent sources all the information he obtained. After giving a description of the islands and sketch of their history, Mr. Man proceeds, working on the lines laid down in the Anthropological Notes and Queries, to a careful consideration of the constitution of the Nicobarese, which he prefaces with an outline of certain facts and ethnic characteristics in support of the racial affinities of the Nicobarese with the Indo-Chinese races. From measurements taken of 150–200 individuals at the different islands, Mr. Man gives the average height of the Nicobarese men as 5¾, and of the women as 5 feet, a result which disproves the statements of earlier writers regarding the disproportion which exists between the sexes in respect of size. The coloration of the skin pigment of the face, chest, back, arms, and thighs is found to differ in a more or less marked degree in each individual ; the two former are usually of a distinctly lighter shade than the last three. Another error needing correction is the assertion that these people can carry without any trouble 200 cocoa nuts, or 5 cwts., whereas it appears that in spite of their undoubtedly fine physical development the maximum load which a Nicobarese can carry may be reckoned as from 160–180 lbs. In the absence of statistics it is difficult to speak with certainty, but from personal observations extending over 17 years it would seem that the average length of life among these islanders is higher rather than lower than it is among the natives of the adjacent continents : the extreme limit of life actually noted is a little over 70, and 80 may be regarded as the maximum ever attained. With reference to the numerical strength of the aboriginal population, a census taken by Mr. Man a year or two ago proves that nearly half the population of the group is contained in Car Nicobar, where a decided increase is taking place, as is also the case at Chowra Teressa and Bompoka. In the central and southern portions of the Archipelago the small ratio of the juvenile element points, however, to a diminution in those islands of the number of inhabitants. It is satisfactory to learn that, though not entirely exempt from the evils which seem inseparably connected with advance in civilization, it does not appear that the Nicobarese have suffered either physically or morally from their contact with Europeans during the past 19 years.

Entomological Society, July 4.–Dr. D. Sharp, President, in the chair.—Mr. Enock exhibited male and female specimens of a spider received from Colonel Le Grice, R A., who had captured them at Folkestone on May 27 last. They had been submitted to the Rev. O. Pickard-Cambridge, F.R.S., who identified them as *Pellenes tripunctatus*, a species new to Britain. Mr. Enock also exhibited specimens of *Merisus destructor* (Riley), an American parasite of the Hessian fly.—Mr. Wallis-Kew exhibited larvæ of *Adimonia tanaceti* found in Lincolnshire feeding on Scabious.—Mr. Porritt exhibited a number of specimens of *Arctia mendica*, bred from a batch of eggs found last year on a species of *Rumex* at Huddersfield. Mr. Porritt said that this species, in the neighbourhood of Huddersfield, was often more spotted than the typical form, but he had never before seen anything approaching in extent the variation exhibited in these bred specimens. Out of forty-four specimens not more than eight were like the ordinary type of the species.—Mr. M'Lachlan exhibited specimens of *Palingenia longicauda* received from Rotterdam.—Mr. Jacoby exhibited the following species of Phytophagous Coleoptera from Africa and Madagascar, recently described by him in the Transactions of the Society, viz. :—*Lema laticollis*, *Cladocera nigripennis*, *Oedionychis madagascariensis*, *Blepharida intermedia*, *B. nigromaculata*, *Chrysomela madagascariensis*, *Sagra opaca*, *Blepharida ornaticollis*, *B. laterimaculata*, *Mesodonta submetallica*, *Schematizella viridis*, *Spiiocephalus viridipennis*, *Apophylia smaragidipennis*, *Aethonea variabilis*.—M. Alfred Wailly exhibited a large number of species of Lepidoptera and Coleoptera, recently received by him from Assam, from the West Coast of Africa, and from South Africa. He also exhibited eggs and living larvæ of *Bombyx cytheræa*, and made remarks on the life-history of the species.

Mineralogical Society, June 28.—Prof. Jas. Geikie, F.R.S., in the chair.—The following papers were read :—A mangano magnesian magnetite, by Prof. A. H. Chester, Hamilton College, U.S.A.—The distribution and origin of the mineral albatile in Ross-shire, by Hugh Miller, F.R.S., of H. M. Geol. Survey.—Elaterite, a mineral tar in old red sandstone, Ross-shire, by Mr. W. Morrison, Dingwall Academy.—These papers were accompanied by various analyses, by Prof. J. Macadam.—The rock-forming feldspars and their determination, by Mr. Alex. Johnstone, and A. B. Griffiths, F.R.S.E.—A Scottish locality for boruite, with analyses by Prof. Macadam, by Rev. W. W. Peyton.—Minerals of the Treshinish Isles, by Prof. Heddle.—On the zeolites of rye water, Ayrshire, by Prof. Heddle.—Prof. Macadam communicated various analyses of coals, of head dies, and of diatomite.—Minerals were exhibited by the Duke of Argyll, Dr. Balfour, Prof. Macadam, Mr. Peyton, and Dr. Black.

Paris.

Academy of Science, July 9.—M. Janssen, President, in the chair.—On cyclones, by M. Mascart. Referring to M. Faye's last communication, the author accepts as a concession the remark that at all events in fixed depressions currents arise about the periphery, which have a more or less *convergent* tendency. He also quotes the full text from Mohn's work, showing that this meteorologist admits an *ascending* motion in tropical cyclones, and is consequently opposed to M. Faye's theory.—On the figure of the earth, by M. H. Poincaré. The object of these calculations is to ascertain whether it be possible to find a law for the varying density in the interior of the globe which shall satisfy at once (1) Clairaut's equation; (2) the observed value $\frac{1}{293}$ of the flattening; (3) the observed value 305·6 of the constant of the precession. The conclusion arrived at is that no hypothesis on the law of densities will satisfy these values.—The number of centenarians in France according to the census of 1886, by M. Emile Levasseur. Of the 184 returned as centenarians, 101 are shown to have been classed in this category by error. For 67 of the others no documentary evidence was forthcoming, leaving 16 whose claim to the honour appeared to be fairly well established. Joseph Ribas, the oldest, was born at San Estevan de Litera, in Spain, on August 20, 1770, and was still living at Tarbes in 1888, and is consequently now close upon 118 years old. The greater proportion belong to the south-western provinces, and as far as can be judged from available data there is no reason to suppose that they are either more or less numerous now than in former times.—Formula for the calculation of longitudes by means of chronometers, by M. Caspari. By the formula here worked out the author has determined a correction of 2″·45 for Hai-Phong, Tongking, which differs little from the 2″·93 which M. La Porte has recently obtained by the telegraph.—On the position of Timbuktu, by M. Caron. The approximate position of this place is found to be 16° 49′ N. lat.; 5° 12′ W. long., which differs considerably from Barth's 18° 3′ 45″ N.; 4° 5′ 10″ W.—On the determination of the constants and dynamic coefficient of elasticity of steel, continued, by M. E. Mercadier. These researches lead to the general conclusion that the strictly *elastic* properties shown in vibratory or other phenomena of a transitory nature should be carefully distinguished from the physical properties accompanied by permanent distortion. The former vary but slightly, the latter considerably in the different kinds of hard and soft steel.—On the propagation of the sound produced by firearms, by M. de Labouret. The apparent increase of velocity is explained with M. Journée on the hypothesis that the projectile at each successive instant of its motion through space is the centre of a fresh concussion. The series of observations here recorded gives results for the velocity of the sound, which are mainly in accordance with the theoretic calculations.—A new method for the measurement of the electric resistance of saline solutions, by MM. E. Bouty and L. Poincaré. A process is described by means of which the difficulties may be overcome, which are met with in the application of ordinary methods to salts in solution at temperatures ranging from 300° to 500° C. The results agree sufficiently well with those previously obtained by M. Foussereau by a different process for temperatures from 329° to 355° C.—Actino-electric researches, continued, by M. A. Stoletow. The author here describes an apparatus constructed by him for the purpose of studying the actino-electric currents in diverse gases and vapours, and under diverse pressures. At ordinary pressure he finds little difference between dry air, moist air, and hydrogen, while for carbonic acid the current is nearly twice as strong.—On some compounds of yttrium, by M. A. Duboin. To the few combinations of yttria hitherto obtained by the dry process the author here adds the silicate of yttria, gadolinite of pure yttria, and the crystallized oxide of yttrium.—Syntheses by means of cyanacetic ether, by M. Alb. Haller. By the process already described for the preparation of the corresponding benzoyl, acetyl, propionyl, and other ethers, the author has succeeded in obtaining the synthesis of the orthotoluyl, phenylacetyl, cinnamyl, and dicinnamyl cyanacetic ethers.—On the alkaloids of cod liver oil, by MM. Arm. Gautier and L. Mourgues. It is shown that this substance contains several alkaloids, some very active; but the present paper deals mainly with the leucomaines obtained by the authors from the yellowish oils yielded both by the Norwegian and Newfoundland cod.—On paradoxal deafness and its treatment, by M. Boucheron. This curious affection, the paracousia of Willis, in which the patient is deaf to words uttered in the silence of a room, but not in a noisy street, is here carefully studied and found to be a variety of otopiesis.—A fishing basket for deep sea hauls, and an electric apparatus for illuminating the oceanic depths are described and illustrated, the former by Prince Albert of Monaco, the latter by M. P. Regnard.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Tabular List of Australian Birds: E. P. Ramsay (Sydney).—Flora of the North-East of Ireland: Stewart and Corry (Belfast Naturalists' Field Club).—Lewis's Medical and Scientific Library Catalogue (Lewis).—Charles A. Gillig's Tours and Excursions in Great Britain: S. F. Smart (United States Exchange).—Numerical Examples in Practical Mechanics and Machine Design: R. G. Blaine (Cassell).—Austrian Health Resorts: W. F. Rae (Chapman and Hall).—An Illustrated Manual of British Birds, Part 4: H. Saunders (Gurney and Jackson).—Euclid's Method or the proper way to treat on Geometry: A. H. Blunt.—Experimente über die Bacterienfeindlichen Einflüsse des Thierischen Korpers: Dr. G. Nuttall.—Annals of Botany, vol. 2, No. 5 (Frowde).—Annalen der Physik und Chemie, 1888, No. 8*b* (Leipzig).—The Auk, vol. v. No. 3 (New York).—Notes from the Leyden Museum, vol. x. No. 3 (Leyden).—Studies from the Biological Laboratory, Johns Hopkins University, vol. iv. No. 4 (Baltimore).

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