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THE COLOURS OF INSECTS CLASSIFIED ACCORDING TO THE METHODS OF ART.

Observations on the Coloration of Insects. By Brunner von Wattenwyl. Translated by Edward J. Bles, B.Sc., King's College, Cambridge. Pp. 16, and 9 Coloured Plates. (Leipzig: W. Engelmann, 1897.)

THIS publication consists of a series of nine beautifully coloured plates containing 118 numbered figures, in addition to several others distinguished by letters. Accompanying the plates is a brief descriptive letter-press which explains the plan on which the illustrations have been selected and grouped, and the theoretical views of the author, the eminent orthopterist. The expense of the plates, which must have been very heavy, was aided by a grant from the Wedl Fund of the Imperial Academy of Sciences in Vienna.

The translation is, on the whole, extremely good, only a sentence now and then serving to recall the (to us) clumsy form of the original. Mr. Bles, in a cautiously worded translator's note, excuses himself from the acceptance of the author's philosophy.

The printing and general get-up are of the very highest character.

The views of the author upon mimicry, protective resemblance, &c., are already well known from his previous writings. Thus in 1883 he suggested (*Verh. der K.K. zool. bot. Ges. in Wien*, 1883, p. 247) the term "Hypertely" to express the supposed fact that resemblance to surroundings may be more perfect and detailed than is required by the struggle for existence. Thus Brunner could perhaps accept the view that resemblance to a leaf is useful for concealment from enemies, although likeness to a leaf which has been mined by larvæ went, he contended, too far, and transcended the limits of the useful. It was therefore of the highest interest to ascertain whether the criticism of so distinguished an entomologist was purely destructive—for "Hypertely" merely meant that he could not accept the explanation offered by natural selection—or whether he had not some alternative theory to explain the facts. Hence the expectant interest with which this publication will be received by all naturalists who are interested in theories which are supposed to account for evolution.

In the Introduction the author describes the plan of his memoir in these words: "The following work contains simple observations on the phenomena of coloration. I have attempted to classify these phenomena, and I have found laws which have no connection with the care for the preservation of the species." These "laws" consist in classifying a large number of the colours and patterns of insects according to their forms, and especially according to the relationship they bear to the various methods of decorative art as applied by man.

It must be regarded as a serious error that the author should have used a monograph of this kind for the burial, rather than the publication, of the description of a few new species.

The following groups are recognised and beautifully illustrated in the plates: (1) *Uniform and Rainbow Coloration*, the simplest and commonest of all; and next to it (2) *Stripes, Bands and Spots.* Under this head it is well shown that the stripes often persist over certain contours or surfaces of the body, regardless of the various anatomical features which are traversed; and also that the continuity of stripes can only be made out, in certain cases, by placing the insect in its position of rest. When an insect possesses a "single narrow band which extends, mostly in a straight line, over the different parts of the body, sometimes vertically, sometimes horizontally or obliquely," and when this band only becomes continuous in a certain position of the insect, Brunner calls it (3) *The Line of Orientation*, "because it indicates the position assumed by the insect in receiving its coloration." (The form of words used should be noted.) Numerous excellent examples of such lines are figured. The next group consists of (4) *Strokes and Dots*, a special form of pattern which gives "the impression of a simple pen-and-ink drawing." A certain West African Locustid (*Mustius Afzelei*) is "marked with a pen-and-ink design" in the form of rings round the antennæ, on the borders and tips of the wings in the position of rest, and on the ends of the feet. A detailed description is given by the author "in order to show that in this insect the pen-and-ink markings are, so to speak, the finishing touches to the coloration of the insect." (5) *Eye Spots.* A beautiful series of these striking markings has been selected and figured. The species belong to the Coleoptera, Orthoptera and Lepidoptera. (6) *Spirals.* Another very striking and remarkable form is found in many moths and in the Mantid family *Harpagidæ*, which, however, are described under Section 9. (7) *Splash Marks* are distinguished from the markings hitherto described by their irregularity and want of symmetry. In two species of *Aularches* from the Oriental region, "the effect of the whole is as though the insect with folded wings had been irregularly splashed with a body-colour." Splash marks when crowded may be modified into (8) *Clouded Markings*, although in this case the pigment is "not applied like a body-colour." The author, "speaking figuratively," prefers to "regard these markings [as in the fore-wings of *Œdipodidæ*] as produced by the impression of a thumb moistened with colour."

Up to this point coloration has been considered "as though produced by painting with a brush. Besides this, forms of coloration are met with which imply, when carefully considered, another method of application." The first of these are (9) *Stencil Patterns*, in which "the colour is perfectly uniform throughout with hard contours, like the wall paintings produced with the aid of stencil plates." "In many instances, various colours are laid on in different shapes, like in polychrome decorations." The examples are selected from dragon-flies and Orthoptera. The realistic manner in which the author follows up his own metaphor is well shown in his description of the marking on the fore-wings of the Harpagid (*Mantidæ*) *Pseudocreobotra ocellata* from Natal.

"One sees on the transparent, somewhat yellowish ground of the fore-wings, firstly, a green patch laid on as with a stencil. Then, in the middle of the green portion, opaque citron-yellow is laid on in the form of a spiral. The spiral is bordered with a heavy black line,

and in the centre of the spiral there is a round spot of the same colour. The black line obviously is meant to serve as a setting of the yellow spiral,"

but it is somewhat misplaced in the design, being shifted, together with the central spot, towards the base of the wing.

"We have, consequently, three colours stencilled on the glassy wings: first green (Fig. 70*b*), then lemon-yellow (*c*), and, to complete the picture, a black body colour; the latter is somewhat misfitted, as it may also be at times in our coloured prints."

All the specimens examined were found to exhibit the same displacement of the black band, so that it is not "a mere chance occurrence in an individual." The author reaches the remarkable conclusion—"The species was ornamented *once for all*, and just as it emerged from this operation, so has it been transmitted by inheritance." Stencil painting also occurs in Lepidoptera, although it requires "a little good will" to find it. Indeed Brunner is inclined to look upon this as the primitive coloration, which has been in the Lepidoptera "frequently effaced by selection and by simply going to the bad."

The transparent patches which occur on the wings especially of Orthoptera and Lepidoptera are classed under (10) *Erosion.*

These ten groups of marks are followed by general Sections dealing with the alterations which occur in pattern as it is traced through a series of allied forms. In Section (11) *Changes of Pattern*, it is pointed out that unlike the *Pseudocreobotra*, described above, the outlines of spots and stripes and even their position are variable in Lepidoptera.

The author therefore compares

"the first method of coloration with colour printing, and the latter with hand painting; thus indicating the fact that on one hand we meet with undeviating similarity, and on the other with a certain freedom."

The methods by which the changes are effected are then considered in (12) *Enlargement and Diminution of Spots and Bands*, (13) *Dislocation*, the change in position which corresponding marking may undergo in allied species, principally illustrated from the *Hesperidæ*. (14) *Diminution of Patterns*, in which a "pattern remains unchanged and only diminishes in size." The fascination for metaphor which possesses the author leads him to say concerning diminution (as opposed to "the simple breaking down of a design"),

"We have a process before us, which is carried out physically when a magic lantern picture is diminished on the screen by manipulating the lenses."

The title of Section (15) is *Changes of Colour due to Adaptation.* Although the choice of these words seems to imply the recognition of natural selection, such an explanation is by no means congenial to the author. After alluding to his previous description of a Locustid from the Soudan which resembles an ant, the shape of the latter being indicated in black pigment on the body of the former of which all other parts are coloured with a pale tint, he inquires "is this imitation an accidental freak of nature?" Indeed throughout this section Brunner seems to doubt his own explanations. He gives numerous instances of insects living on plants "in which the leaves of the habitat or parts of them are doubtlessly imitated"; but follows the list, which is illustrated by eight figures, with the paragraph—

"With the aid of the imagination, one may recognise the most various figures in the arrangements of spots and ocelli, and if, perchance, these can be referred in any way to protective resemblance, your case of mimicry is established."

Apart from the fact that such a description is a caricature, exception must also be taken to the inconvenient confusion between protective resemblance and mimicry, two principles which, although bearing a close relationship to each other, are better kept separate.

(16) *Staining of Contiguous Parts.*—This Section contains the somewhat crude and entirely unsupported assertion that when an intensely coloured part of the body is of the same tint as other parts which are in contact with it, the latter have been stained by the former. Careful microscopic investigation at the time during which the pigments are developed would settle the matter, and without it no such assertion can be justified.

(19) *Fading in Covered Parts.*—In many instances the parts of wings which are covered in the position of rest are of a different tint from the exposed portions. From this well-known fact, and without the remotest attempt at proof, the author observes

"these facts convey the impression that the brighter colours are produced by daylight. If one exposes to the action of the sun and of the air several sheets of white paper of different sizes lying one upon the other, then, in a short time, the silhouette of the smaller pieces will stand out on the larger either in lighter or in darker tints. It is probable that the phenomena observed in Blattodea and Phasmodea belong to this category of light effects."

The author's method of dealing with natural selectionists may be fairly used against himself. If, perchance, it is possible to institute a crude comparison between the colour effects produced by physico-chemical forces upon dead matter, and the arrangement of tints in a highly organised being, you have probably established a valuable "law" which you can then place before the world, without troubling to inquire whether you have been misled by a resemblance which is purely superficial.

(18) *Colouring in Relation to Position.*—In this Section the patterns which pass over the body irrespective of its parts, and produce a "homogeneous" effect, are distinguished as *holotypic* from those *correlative* markings which are similar upon homologous parts, as in the repetition of ocelli upon the corresponding areas of fore and hind wing, &c. Numerous interesting and beautiful illustrations are given. It is common for the same insect to possess more than one holotypic pattern having reference to more than one position. This at least is the way in which a follower of natural selection, or indeed a Lamarckian, would express the facts, and he would then attempt to ascertain the meaning of the patterns in relation to the positions. Brunner expresses them very differently and in a manner which is significant of his views of creation. With him the position represents the attitude of the insect when the pattern originally fell upon it. Such a view is expressed again and again, the best example being contained in the next and last

Section (19) dealing with *Arbitrariness of Coloration* (viz. the fact that colouring often has no "reference to the somatic importance of organs"). He here speaks of a black Australian bug of the genus *Pirates*, in which the wings of the male and the abdomen of the wingless female are similarly striped and spotted with dirty yellow. "What, then, does this mean? When the pattern was produced, it fell upon the wings of the male, and in the female on the uncovered abdomen."

There is a conspicuous want of method and arrangement in the Sections recognised by the author. Thus the idea of a pattern which persists over the body surface independently of structural features but related to attitude, is the central conception of many of the Sections, and even those as widely separated as (3) is from (18) and (19). It is interesting to compare this point of view with that of the late Alfred Tylor, who ingeniously attempted to show that the true significance of pattern is to be found in its relation to underlying structure. Undoubtedly many patterns possess this relationship, and undoubtedly many others as conspicuously lack it. The facts on which both naturalists relied are certainly right, while their conclusions are as wrong as they are contradictory of each other—Brunner, that pattern is produced upon the organism by some power outside it, and caring nothing for its structural differentiation; Tylor, that there is some deep and significant bond between pattern and underlying structure, so that the former becomes the outward and visible sign of the latter.

The attempt has now been made to give the whole of the "laws which have no connection with the care for the preservation of species" which the author claims to have found. To the majority of naturalists these "laws" will appear to be the grouping of certain markings and patterns according to more or less superficial resemblances between them; and this being done, the real interest now begins—the attempt to ascertain their significance in the lives of their possessors. Much interest, too, awaits a minute investigation of many of the groups in order to make out whether they are based on superficial appearances, and therefore artificial, or whether they are real and natural.

To the author, however, it all means far more than this. As the memoir was being studied, the continual pursuit of detailed metaphor led to the belief that the author did not regard his imagery as metaphor only. In the brief Conclusion he speaks out on the question.

"In the above paper I have brought into a system the divergent facts of coloration. In so doing, simple principles have been formed which coincide in a remarkable manner with those of the human painters' arts. The agreement is so striking that one is tempted to use the terms of our own technique in descriptions. I speak of splashing, stencil-painting and brush-painting, also of the position of the insect when the colour was applied, of sketching in the pattern in different ways, &c."

"This is figurative language, but the uniformity of the phenomena forces one to the conjecture, that the process in nature is of a similar character; that is to say, a phenomenon which acts from without, independent of the biology of the animal coloured and in nowise connected with its structure."

When we inquire what this power can be, the author replies as follows:—

"The exact sciences have accustomed us to refer all natural phenomena to the action of definite, inviolable laws. In the coloration of insects, however, we meet with an *arbitrariness* striving to produce attributes without regard for their possessors and, therefore, obviously to be looked upon as the emanation of a Will existing above the universe."

Thus Brunner leads us back to a form of special creation. Paley was convinced by the argument of design; Brunner by the argument of want of design. Most of us, while rejecting both, will distinctly prefer the philosophy of the old theologian to that of the great orthopterist.

The "Will existing above the universe," the Will which Brunner supposes to work out "purposes in creation far more lofty than the mere preservation of the species," is mainly to be recognised by the resemblance of its handiwork to that produced by the methods of the craftsman, and especially by the remarkable likeness which it presents (as in the wrongly-placed stencil pattern) to a poor form of human art, at its worst.

The reasons given for rejecting the Darwinian explanation are indeed remarkable, but far more remarkable are the hypotheses which the objectors prefer to put in its place. E. B. P.

BLANFORD'S BIRDS OF INDIA.

The Fauna of British India. Birds, Vol. iv. By W. T. Blanford. 8vo. Pp. xxi + 500. (London: Taylor and Francis, 1898.)

THE present volume completes the Vertebrates of the Indian Fauna, and the editor (in this case also the author) is to be congratulated on having thus far so successfully accomplished a very important and at the same time a very difficult task. The volume before us is, perhaps, the most generally interesting of the four devoted to birds, seeing that it treats of groups like the pigeons, the sand-grouse, the game-birds, and the ducks and geese, which claim attention from a wider circle of readers than is attracted by the perching birds and picarians. Since the author, in addition to his scientific qualifications, is also a sportsman who has shot a large number of the species he describes, his work can scarcely fail to prove as acceptable to his brother sportsmen as to scientific ornithologists. Limitations of space have necessarily curtailed the amount of matter devoted to the habits of most of the species, but within such limitations the notices leave little to be desired.

From its geographical situation, India, we need scarcely remind our readers, is visited during the cold season by vast swarms of game-birds and ducks of various kinds; and the fauna of these groups is consequently very much larger than might *à priori* have been expected. Sportsmen accordingly often experience considerable difficulty in identifying the species contained in their "bag," but with the publication of the present volume such difficulties should cease.

Turning to the more strictly scientific aspect of the book, it may be noted that the author is careful to state how much he is indebted to the British Museum Catalogue of Birds, certain volumes of which devoted to several of the groups he describes have appeared at more or less recent dates.

On comparing these volumes of the Museum Catalogue with the work before us, it will be found that in many instances Mr. Blanford has somewhat simplified the classification adopted. This is most markedly the case in the pigeons, the existing members of which were divided by Count Salvadori into five families; whereas Mr. Blanford, so far at least as Indian forms are concerned, admits but one. Although he has not to deal with the former on this occasion, he further suggests that the separation of the *Tetraonidæ* as a family apart from the *Phasianidæ* seems scarcely justifiable by the facts. And on turning to the minor groups, we find a similar wide and comprehensive view taken as to their respective limitations. Leaving out of consideration the very distinct demoiselle crane (*Anthropoides*), it may be noticed as an example of this feature that recent writers have assigned the three species of true cranes which visit India proper to as many distinct genera, respectively distinguished, mainly, if not entirely, by the comparatively insignificant character of the extent to which the head is clothed with feathers. All the three species are indeed structurally similar and essentially the same type of bird, and to many at least it will be a source of satisfaction to find them once again reinstated in the original genus *Grus*. Possibly a further improvement would have been to have placed the Burmese representive of the Sarus crane of India as a sub-species rather than a species, but this is a matter of detail.

In museum work (as in stamp-collecting) there seems to be an inevitable and inherent tendency on the part of specialists to go on refining and discriminating in the detection of small points of difference, and thus to raise the individuals or groups in which such minute points of difference occur to a higher and higher rank. And in consequence of this extremely natural ultra-refinement (due to a ripe knowledge of minuteness of detail), the mutual affinities of animals tend to become obscured or even lost, while the science is cumbered with an excess of more or less superfluous terms. It is therefore a distinct advantage when a man with the wide experience and knowledge derived from the study of other groups, possessed by the author of the present volume, sets himself the task of revising the classification of a group which has occupied the attention of a large number of specialists. And whatever may be the opinion from the specialist point of view, it can scarcely be doubted that to naturalists who desire to take a broad and comprehensive view of zoological affinities, Mr. Blanford's simpler arrangement is decidedly preferable to the numerous sub-divisions adopted by some of his fellow workers.

As regards the general classification adopted, it is gratifying to notice that it has not been considered necessary by the author that he should propose any new scheme; and the various major groups accordingly, for the most at any rate, appear under the old familiar names. In some instances, however, generic terms in common use have had to be rejected on account of priority or preoccupation, and a few birds consequently appear under unfamiliar titles. The horned pheasants, for example, figure as *Tragopan* in place of *Ceriornis*, but since the former name is often used as the popular title of these birds, the change in this case is less startling than usual. As in all those made by the author, this substitution was a necessity according to the rules of nomenclature.

The total number of Indo-Burmese birds regarded as entitled to rank as distinct species in the four volumes devoted to the group is given by the author as 1626. Years ago, from a much smaller area, Jerdon recognised 1016. In Mr. Hume's catalogue of 1879 a total of 1788 entries were recorded, but of these 106 were rejected as invalid, and 74 regarded as doubtful, thus leaving a total of 1608, or very nearly the same as the number admitted by Mr. Blanford and his fellow author Mr. Oates. Since a large number of new species have been described of late years, this indicates that due attention has been given on the part of ornithologists to the elimination of nominal ones. An exact estimation of the number of species of any group of animals inhabiting a particular country must, however, depend to a considerable extent on the personal equation of the describer. As the author well observes:—

"The precise number of species is naturally dependent on a personal factor, some writers being more liberal than others in admitting the claims to specific rank of races which are distinguished by small differences of plumage or measurement, or which are connected by intervening links with the typical form. Such races or sub-species, as they are called, have not, as a rule, been separately numbered and described in the present work, but they have received due notice and their characters have been explained."

From this it would appear that Mr. Blanford has not yet brought himself to accept the principle of trinomialism for birds, although his recent paper on the large Indian squirrel seems to show that he has already done so in the case of mammals; and the innovation would, to our thinking, be an advantage among the former.

As is always the case with the author's work, his descriptions are most accurately and concisely written, and they all bear the impress of having been drawn up afresh from the birds themselves, and not merely extracted and furbished up from the writings of others. In many of the groups described, and especially the game-birds, the females are so different in plumage from the males, as to require a description nearly as long as that devoted to the latter, so that the labour involved in the work is almost double that which might at first sight be supposed necessary. Equally exact, and at the same time important, are the details given in connection with the geographical range of the genera and species; a subject too often neglected by the earlier writers.

One thing we should like to suggest to the author, and that is that in future works he should give the reference to the place of publication of the generic names and their synonyms, instead of merely citing the author and date. The characters of the eggs in each genus might also have been added; while a few more details regarding the nesting habits of some of the more important species would, if space permitted, have added to the interest of the book.

Many books on Indian game-birds and the kindred groups are already in existence, and a new one on a small scale is now in course of publication; but it may be safely said that as a work of reference, embodying all the important information regarding these groups, the

present volume will long remain the standard, both to the naturalist and to the sportsman. While lacking the advantage of plates, it has the compensations of portability, accuracy, and completeness; and it forms a worthy companion to its fellow volumes of the same series. R. L.

NAVIGATION AND CYCLONES.

Méthode pour abréger les traversées en utilisant les perturbations de l'Atmosphère. Par M. A. Fieron, capitaine de frégate. Pp. 91. (Paris: Imprimerie Nationale, 1891.)

THIS little book bears the date 1891, and is extracted from the *Annales hydrographiques* of that year. The object of the author, who was attached to the *Calédonien*, and thus had considerable experience of the Southern Seas and of the weather prevalent in those latitudes, is to indicate methods by which navigation may be facilitated and the duration of voyages, in sailing ships especially, diminished by taking advantage of the cyclonic and anticyclonic movements in the atmosphere. By so manœuvring that the violence of the storm is utilised in carrying the ship in the direction desired, it is contended that these destructive agents can be turned to useful account. It may be true, as the author asserts, that in every area of low pressure there is always one part which can be made useful—one sector in which favourable winds will be found. But careful navigators are rather prone to give these areas of disturbance a wide berth; and it speaks much for the trustfulness of the author, and of the calm confidence in which he reposes on scientific deductions, that he does not propose to avoid these dreaded cyclonic storms, but is prepared to steer into their midst and make their violence subservient to his ends. His system is based upon instrumental observations, chiefly of the barometer, from which may be learnt the direction and force in which the cyclone is moving. Experience teaches the behaviour of the atmosphere in a region of low pressure in different latitudes, and by the aid of a few rules, easily learnt and remembered, it is not difficult to perceive whether one be on the navigable or dangerous side of a cyclone, and arrange accordingly. The author therefore gives in very considerable detail, the condition of the weather, the direction of the wind, and the appearance of the sky, which may be expected in the various positions in which the ship finds itself relative to the centre of the storm.

We have practically to do with a system of weather forecasting, based upon knowledge which cannot always be exact or sufficient, and therefore it would seem must sometimes lead astray. But the author declares that he has never been in error, and that he has never had any hesitation in selecting the proper route which would enable him to find the most favourable wind to carry him most swiftly in the direction he desired to travel. He is, however, careful to add that his rules for observance apply only on the open ocean, where land masses do not interfere with the aerial current, and his success may be to some extent due to the employment of the system under the conditions of the greatest simplicity.

This work has been before the maritime public now some seven years, and presumably the procedure has been submitted to frequent test by those who have to navigate in those seas, which have been made the subject of study, but the testimony in its favour does not seem to be overwhelming. Several causes may be assigned to explain the indifference with which the practical suggestions contained in the book have been received by the mariner and the shipowner. The most evident is the steady decline in the tonnage of sailing vessels, and the tendency to convert many of these into floating warehouses containing grain. When a shipowner knows that he will have to pay rent for storage of the cargo on arrival, he is practically indifferent how long the voyage may last, and safety is of greater consideration than swiftness. The recognition of trade routes and the maintenance of particular lines of navigation pursued by vessels which can both steam and sail, forbid a haphazard, self-selected route, which, if it shorten the time of passage, increases the chances of collision. The author, it is true, considers his system particularly applicable to this kind of steamer, employing the steam to carry the vessel into a position in which it would enjoy favourable breezes. A few tons of coal would be well expended, he urges, if it enabled a skipper to bring his steamer alongside a friendly cyclone which would carry it along on a twenty-knot breeze in the coveted direction. We imagine that the few tons of coal would more frequently be expended in carrying the ship away from a region in which disaster is quite as likely to be encountered as material assistance to be rendered.

Possibly, knowing the destructive effects that these cyclones can work, our mariners have received them with too much distrust, and not sought to derive from them what little advantages they may offer. M. Fieron's book is directed towards creating a more favourable opinion of these atmospheric disturbances. The issue must be left to the expert, who has before his eyes Board of Trade inquiries and nautical assessors who may not share the hopeful views of the author. One very real source of danger on which the author does not appear to insist sufficiently is the swell which arises from the heavy seas, that accompany typhoons, tornadoes, &c. A well-found sailing vessel may withstand the force of the wind, after due precaution, but suffer grievously from heavy confused cross seas. This point and others of much importance are discussed in a pamphlet recently issued by Dr. Doberck, the director of the Hong Kong Observatory. The director has here incorporated the experience of many years' study gained in an observatory which exists mainly for the purposes of warning the mercantile marine against the dangers arising from the approach of typhoons and similar atmospheric disturbances. During the last thirteen years, the tracks of nearly 250 typhoons have been examined and discussed, from information supplied, either from ships at sea, or from fixed stations. The causes that produce variation from regularity, such as the geographical position of the origin of the storm, the presence of land masses in the path, the condition of the monsoon, &c., have been taken into account, with the result that successful prediction is generally secured, and rules for the management of vessels, under whatever conditions they are placed, have been formulated with scientific precision.

OUR BOOK SHELF.

Notes from a Diary, 1873-1881. By the Right Hon. Sir Mountstuart E. Grant Duff, G.C.S.I. Vol. i., pp. iv + 334; Vol. ii., pp. 394. (London: John Murray, 1898.)

THE only scientific interest which these volumes possess is due to the fact that a number of distinguished men of science are referred to in their pages, and occasional mention is made of botanical species found in the places visited by the author. Chatty reminiscences of this kind are always interesting, and they become much more so when they are related by a man with a wide circle of friends among leaders in many branches of intellectual and political activity. Almost all reference to the working-day part of the author's life has been eliminated, though during the whole period covered by the volumes the author was a member of Parliament actively engaged in political affairs. The volumes are concerned with the lighter and recreative side of the life of a public man, and as such contain notes on many amusing occurrences, as well as open expressions of opinions by distinguished men. Whether it is desirable to give a permanent form to stories told in private conversation, or to record casual opinions, may be doubted; but, by bestowing care upon the preparation of the notes for the press, Sir Mountstuart Grant Duff has been able to avoid publishing anything likely to give offence.

The volumes will provide after-dinner speakers with a wealth of capital anecdotes. In 1877 the author was shown an egg of the great auk, and was told that on account of its rarity it was worth 60*l*. Since then, a great auk's egg has been sold for nearly 300*l*. Referring to the auk the author says: "This was the creature whose name brought down on the ornithologist who used it at the Belfast meeting, the criticism of the lady who remarked—'He can't be an educated man, he speaks of the great 'awk!'" The following entry in the diary for March 24, 1878, is interesting:—

"At High Elms, Lyon Playfair, amongst others, being of the party. *A propos* of the Algerian conjurors, who apply hot metal to their bodies without suffering, he explained to us that, if only the metal is sufficiently hot, this can be done with perfect security; and told an amusing story of how, when the Prince of Wales was studying under him in Edinburgh, he had, after taking the precaution to make him wash his hands in ammonia, in order to get rid of any grease that might be on them, said: 'Now, sir, if you have faith in science, you will plunge your right hand into that cauldron of boiling lead, and ladle it out into the cold water which is standing by.' 'Are you serious?' asked the pupil. 'Perfectly,' was the reply. 'If you tell me to do it, I will,' said the Prince. 'I do tell you,' rejoined Playfair, and the Prince immediately ladled out the burning liquid with perfect impunity."

Several stories are told in connection with Darwin. The following is an entry on December 15, 1880:—

"Drove with my hostess to Liverpool. She told me that she had lately explained to Darwin the state of her sight, which is very peculiar. 'Ah! Lady Derby,' said the great philosopher, 'how I should like to dissect you.'"

The volumes are full of accounts of similar amusing incidents, and will serve to while away many leisure hours.

Elements of Descriptive Astronomy. By Herbert Howe, A.M., Sc.D. Pp. 340 + xii. (London: George Philip and Son, 1897.)

THIS is an elementary text-book which touches briefly upon the more important principles, facts, and theories of astronomy. In such a general treatment of a large subject, opinions are bound to differ as to what should be included and what omitted, but the author has on the whole made good use of his space. The arrangement of matter is only marred by the subordinate position given to the spectroscope and the principles of spectrum analysis. While the telescope is treated of in a separate chapter, the spectroscope is given a few paragraphs in a chapter on the sun, an arrangement which is apt to be misleading now that the astronomical applications of the latter instrument are as wide as those of the telescope.

The author wisely insists on the necessity for actual observations, even without instruments, and draws attention to the need for the cultivation of what is happily called the "geometric imagination." Each chapter is provided with a number of exercises which seem to be well adapted to assist the student. The illustrations, including a set of star maps, are, with one exception, admirable. Though the colouring of the plate of spectra is excellent, several of the details are inaccurate: for example, the spectrum of sodium is represented as consisting of a bright line and two dark ones, having no connection with the solar lines, and the hydrogen spectrum is quite unrecognisable.

In spite of the necessarily meagre character of much of the information, the book has many attractive features, and will give the student a good idea of the principal teachings of astronomy.

South American Sketches. By Robert Crawford, M.A. Pp. xx + 280. (London: Longmans, Green, and Co., 1898.)

THREE-FOURTHS of this volume consist of narratives of amusing and exciting personal experiences; the remainder contains general information on the natural history, climatology, and geography of Uruguay. The author resided in Uruguay for three and a half years, during which period he was engaged in the construction of a railway, and had good opportunities of observing the nature of the country and the manners of the people. The life of a railway engineer is never without its adventures, so it is easy to imagine that the author did not lack exciting incidents. Of course he witnessed a revolution, and experienced some of the discomforts suffered during periods of political disturbances in South America. The descriptions of these incidents of public and political life, and of perils by land and sea, are well worth reading. Referring to the change of character of streams in a few hours, Mr. Crawford says: "I have known a little stream that I have repeatedly jumped across on foot spread out to a width of more than a hundred yards, with a depth of from ten to fifteen feet, in five or six hours, and fall again as rapidly." The rivers, as well as the smaller rivulets and brooks, are affected in a similar way.

Though the volume is not expressly intended for schools, it contains enough adventures to interest young readers, and conveys at the same time a large amount of information concerning conditions of life in Uruguay.

The Making of a Daisy; "Wheat out of Lilies"; and other Studies in Plant-Life and Evolution. A Popular Study of Botany. By Eleanor Hughes-Gibb. Pp. 126. (London: Charles Griffin and Co., Ltd., 1898.)

UNDER a cumbersome title, we have here a half-dozen short papers containing elementary descriptions of the parts of a few common flowers and their functions. The object of the author has been "to help my readers to form some idea of the principles on which the classification of flowering plants are based, and at the same time to give a view of the chief divisions marked out upon these principles." There is, however, little novelty either in the plan or execution of the volume; and though a certain amount of instructive information may be extracted from its pages, it is garnished with too many platitudes to be interesting. For readers who like to draw moral lessons from natural processes, the book will be found attractive; but as a popular work on botany little can be said in its praise.

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.*]

Liquid Air at One Operation.

IT is to be hoped that personal matters will not divert attention from the very interesting scientific questions involved. The liquefaction of air at one operation by Linde and Hampson is indeed a great feat and a triumph for the principle of regeneration. But it must not be overlooked that to allow the air to expand without doing work, or rather to allow the work of expansion to appear as heat at the very place where the utmost cooling is desired, is very bad thermodynamics. The work of expansion should not be dissipated within, but be conducted to the exterior.

I understand that attempts to expand the air under a piston in a cylinder have led to practical difficulties connected with the low temperature. But surely a turbine of some sort might be made to work. This would occupy little space, and even if of low efficiency would still allow a considerable fraction of the work of expansion to be conveyed away. The worst turbine would be better than none, and would probably allow the pressures to be reduced. It should be understood that the object is not so much to save the work, as to obviate the very prejudicial heating arising from its dissipation in the coldest part of the apparatus. It seems to me that the future may bring great developments in this direction, and that it may thus be possible to liquefy even hydrogen at one operation. RAYLEIGH.

Terling Place, Witham, June 26.

Liquid Hydrogen.

I OBSERVE with some amusement that you still allow Mr. Hampson to embellish your columns with vain repetitions of accusations which he was compelled to withdraw when he met me face to face at the meeting of the Society of Chemical Industry.

It is idle to discuss any question with a man whose notion of argument is to restate in somewhat different language what has already been refuted, and then to assert that the accuracy of his propositions has not been questioned.

Mr. Hampson must be a singularly dull person if he fails to appreciate the magnitude of the draft he makes upon the credulity of the world. He asks men of the world to believe that he, being convinced of the general dishonesty of Royal Institution methods, and being in possession of a novel and valuable invention, fully completed but not protected by patent, came unbidden and unsought to reveal all the details to a man whom he knew to be my assistant.

He further expects the world to believe that having thus given himself away, he refrained from protecting his invention until the rival inventor had had ample time to profit by his childlike simplicity. But even this is not all; for the world is further asked to believe that after he had placed the Royal Institution in possession of full information concerning a finished invention, it took me more than a year to utilise his generosity, while in the interval Dr. Linde had published his method and apparatus. Does not all this amount to rather a large order?

But perhaps no one can answer Mr. Hampson so well as Mr. Hampson himself. At the meeting of the Society of Chemical Industry on May 2, Mr. Hampson expressed himself as follows (*The Journal of the Society of Chemical Industry*, No. 5, vol. xvii. p. 421):—"Prof. Dewar will do me the justice to say that I have nowhere published any statement that he had made use of anything I had communicated, or of what I had invented. I have, therefore, nothing to withdraw, since I have nowhere suggested that a communication had been passed on to him. . . . I am not to be understood as saying that my proposal was passed on to Prof. Dewar."

What is Mr. Hampson to be understood as saying in the letters you have published, if not the precise contrary of what he said when brought to book at the Society of Chemical Industry?

How otherwise is the "credit of science" involved?

It is worth noting that in March 1896, a year and a half after the famous interview with Mr. Lennox, Mr. Hampson threatened Messrs. Lennox, Reynolds, and Fyfe with legal proceedings on the ground that a lecture apparatus made for my Chemical Society paper of 1895, and subsequently advertised by them in NATURE, was an infringement of his patent. They replied that he might take any action he pleased. He has never taken any.

Mr. Hampson's extract from my speech at the Society of Arts, reported in the *Journal* for March 11, 1898, is so completely isolated from the context as to convey a totally wrong impression. When Mr. Hampson made it, he had before him my statement that "although this regeneration system had been carried by Dr. Linde to the acme of perfection, no one who constructed low temperature apparatus rejected the cool gas without utilising it; the great advance was that Dr. Linde did so completely."

If all that Mr. Hampson wants is "recognition in historical or explanatory works" of his claim to be the inventor of a general claim to intensive refrigeration, he will find Solvay, Dr. Linde, and Prof. Onnes obstacles quite as serious as myself. Further, this attempt to justify going behind my back in his relations with a member of the staff of the Royal Institution, is a too transparent subterfuge to require further comment.

JAMES DEWAR.

The Spectrum of Metargon?

IN the account given by Prof. Ramsay of his researches on the "Companions of Argon," he has omitted to draw attention to a very curious similarity between the spectrum of his new gas "metargon" and the ordinary spectrum of carbon, with which every student of spectrum analysis is familiar.

The following comparison of wave-lengths will make the similarity apparent.

		Ramsay's metargon.	Carbon (Angström and Thalén).
Citron band	1	5632·5	5633·0
	2	5583·0	5583·0
	3	5537·0	5538·0
Green band	1	5163·0	5164·0
	2	5126·5	5128·0
Blue band	1	4733·5	4736·0
	2	4711·5	4714·5
Indigo band		4314·5	4311·0

There are three of Ramsay's bands not included in this list, but these are nearly coincident with known bands in the cyanogen spectrum.

It seems hardly credible that Prof. Ramsay has not guarded against the possibility that all these bands may be due to carbon, and not to a new gas; but some explanation seems required, for though the coincidences in the two sets of bands is not complete, there is no case known in which two different elements have spectra so nearly alike as those of carbon and metargon seem to be. ARTHUR SCHUSTER.

Anatomy of the Swallows.

MY friend Dr. R. Bowdler Sharpe, of the British Museum, has favoured me with a copy of his recent and very useful memoir upon the swallows (*Hirundinidæ*), and we find the group treated under the several heads of (1) an introduction; (2) geographical distribution; and (3) the literature of the Subject. In the last, the author of this contribution has evidently intended to present a very complete list of the titles of works that have been written about swallows, extending between the years 1731 to 1894 inclusive; while in the introduction he makes the statement that "The Swallows appear to us to be such a well-marked and isolated Family of Passeres, that, in the absence of any detailed account of their anatomy and general structure, which, so far as we know, has not been attempted, there remains little for us to say." As one, perhaps, who has had occasion to keep a little better track of the literature of hirundine morphology, permit me to invite the attention of this distinguished systematist to a memoir published by me in the *Journal* of the Linnean Society of London for 1889 (vol. xx. pp. 299–394, with 39 lithographic figures); he will find in it, under the title of "Anatomy of the North-American Hirundinidæ," not only a complete account of the pterylography of every species of swallow in the United States, but myological descriptions of the same; with references to their visceral anatomy; and an entire chapter devoted to the osteology of all the United States genera. Not only this, but on the plates, illustrating the same memoir, Dr. Sharpe will find very accurate figures of the skulls (nat. size) of *Progne subis*, *Chelidon erythrogaster* and *Tachycineta thalassina*—all important forms

of swallows, of which the "anatomy and general structure" are very well known. In that paper he will also see that I have attempted to compare the anatomy of all our swallows, with the structure of the American swifts, and with *Ampelis*, and a great many other birds. This paper of over one hundred pages, and numerous plates, is not found in Dr. Sharpe's "Literature" of the *Hirundinidæ*. Numerous other important works upon the life-history and structure of swallows find no place in Dr. Sharpe's bibliography of this group. In this connection, then, it may be said that our author distinguishes but *twelve genera* of swallows in the world's avifauna, and of these I have carefully compared, illustrated and published full accounts of the anatomy of no less than *six* genera, or in other words fifty per cent. of those known at present to science. And, as *Stelgidopteryx* was included among these, I very much question that any very marked anatomical differences will be found to exist among the unexamined types.

Further, as has been the case with not a few other anatomists, I have treated the subject of the systematic position of the swallows in numerous places, but more particularly in my "Contributions to the Comparative Osteology of the Families of North American Passeres," in which the skeletons of all the passerine birds in the United States were, in a comparative way, passed in review, the swallows with the rest. This is another formal work dealing with the *Hirundinidæ*, overlooked by our bibliographer of this family of birds. R. W. SHUFELDT.

2508 University Place, Washington, U.S.A., June 11.

Rotifers in Lake Bassenthwaite.

IT may be of some interest to readers of NATURE to call attention to the fact that during the warm days of June 16–18, the beautiful Rotifer *Asplanchna priodonta* was to be found in the surface waters of Lake Bassenthwaite, Cumberland, in very great abundance. After dragging a small tow-net through the water from a row-boat for twenty minutes, the water collected in the bottle attached to the end of the net was perfectly turbid with the multitude of these animals, interfering very materially with the observation of the other constituents of the plankton. Observations taken by Mr. Ashworth in different parts of the lake in the early morning, mid-day and the evening, proved that they were not present merely in a localised cloud, but distributed in immense numbers all over the lake, from the surface to a depth of ten feet or more.

The observation is of interest, as the "Lakes" are not given in the great work on Rotifers, by Hudson and Gosse, as a locality for this genus, nor is there mention made of its occurrence in such great numbers. Perhaps some of your readers may be able to inform me if this phenomenon has previously been recorded in England. SYDNEY J. HICKSON.

The Owens College, Manchester.

Lion-Tiger Hybrid.

SOME of the readers of NATURE who have the opportunity of visiting the exhibition at Earl's Court may be interested to know that one of the members of the "Happy Family" now on show there is evidently a hybrid between a lion and a tiger. The animal appears to be about two years old. By artificial light the ground colour closely resembles that of a lion, being tawny rather than reddish yellow; but the tiger-stripes, though faint, are quite visible, especially on the tail. Such stripes might perhaps be mistaken for unusually strong cub-markings of the lion retained for an unusual length of time. But apart from the stripes, the tiger-strain comes out strongly in the blackness of the corners of the mouth, the hairs of the lips in this place being jet black in the tiger, white in the lion. R. I. POCOCK.

Natural History Museum, June 22.

Transference of Heat in Cooled Metal.

J'AI l'honneur de vous envoyer pour votre si intéressant journal, une remarque qui pourra intéresser peut-être quelques lecteurs de NATURE.

Il s'agit d'un phénomène certainement bien connu et qui n'a peut-être pas attiré l'attention des physiciens, comme il semble le mériter. Prenons dans la main l'extremité d'une barre de métal et chauffons l'autre extrémité aussi fortement que possible, mais pourtant de manière à pouvoir tenir la barre sans se brûler par la première extrémité. Cela étant, refroidissons brusquement l'extremité chauffée, soit en la plongeant dans l'eau, soit au moyen d'un jet d'eau. *Nous constatons alors que la température de la partie non chauffée monte et que nous sommes obligés de lâcher la barre, si nous ne voulons pas nous brûler.* C'est ce que savent très bien, tous ceux qui ont travaillé à la forge ou qui ont fait des soudures de petites pièces métalliques tenues à la main. Les ouvriers disent que la chaleur est *repoussée* par le froid vers la partie non chauffée. Le phénomène a-t-il été étudié scientifiquement et connait-on sa cause? HENRY BOURGET.

Astronome adjoint à l'observatoire de Toulouse, juin 14.

Parker and Haswell's "Text-book of Zoology."

IN reply to Prof. Ray Lankester's references to me in his review of Parker and Haswell's "Text-book of Zoology" in this journal for May 12th, I should like to state as follows:—(1) That I had nothing to do with correcting the "final revise" of this book. (2) That the new English edition of Prof. Wiedersheim's "Comparative Anatomy of Vertebrates" is not a translation, but an "adaptation." (3) That the assertion with regard to the ossification of parts of the skeleton in Elasmobranchs in the latter work is not the same as that to which Prof. Lankester objects in the "Zoology," whether the latter be right or wrong. (4) That Götte in 1878 distinctly stated that true bone is undeniably present in the vertebral centra of several Elasmobranchs the histology of which he describes, and that all kinds of intermediate stages between calcified cartilage and true bone occur in these centra. (5) That in the fourth edition of Marshall and Hurst's "Practical Zoology" true bone is said to occur in the centra of *Scyllium*, and that this statement does not appear in previous editions of the book. (6) That in the fourth German edition of Wiedersheim's "Grundriss der vergleichenden Anatomie," which was published a week or two ago, the centra of Elasmobranchs are described as being "kalkknorpelige resp. knöcherne." W. N. PARKER.

SOME RESULTS OF MY RESEARCHES ON OCEANOGRAPHY.

BY ALBERT, PRINCE OF MONACO.

THE devotion that has been quite lately given to the new science called "oceanography," has decided me to dedicate some of the strongest efforts of my life to its advancement. I set about my work in 1885 with a small sailing schooner of 200 tons, the *Hirondelle*, and I explored the Atlantic as far as the coast of Newfoundland, and as deep as 1600 fathoms, without any power greater than the arms of my fourteen sailors. Later on I built a steam vessel of 560 tons, better fitted for such rough work; this was the first *Princess Alice*. Now I

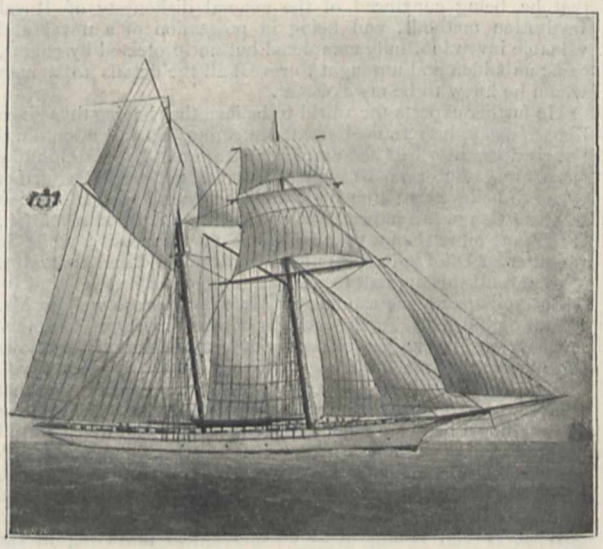

FIG. 1.—The *Hirondelle*.

have just built another one still more powerful, of 1400 tons, also called *Princess Alice*. Thus the love of science, and the successful combat of the difficulties met with in its employment in researches at sea, enlarges constantly the horizon and demands more powerful means.

I began by trying to find out experimentally how the currents moved on the surface of the Atlantic, and for this purpose I dropped, in three different cruises, 1675 floats between Europe and North America. These floats were mostly a strong glass bottle protected by a sheet of brass, ballasted so as to keep just at the level of the surface, and containing a document written in several languages to invite the finders to return it with particulars as to place and date.

Out of these, 226 had been returned to me up to the year 1892, when I drew, by working scientifically the course that each of them had probably been following, a definite map of the currents. And I may add that this result is certainly very near the truth in its general lines, because the elements employed have always been numerous for each region.

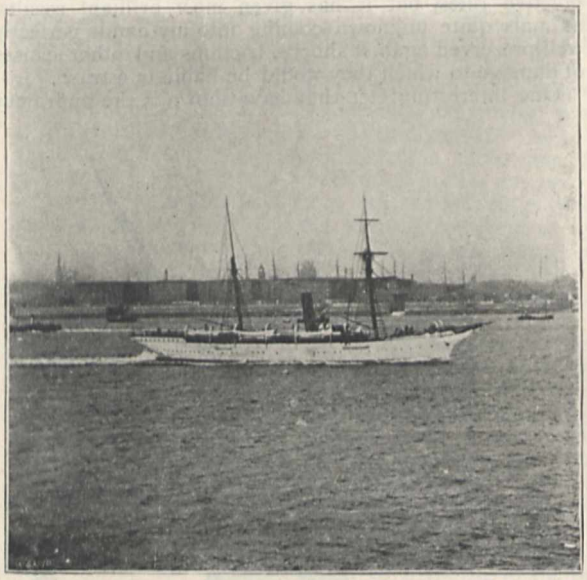

FIG. 2.—The second *Princess Alice*.

The floats have landed on almost all the shores of the North Atlantic, from the North Cape to the south of Morocco, along Central America, and on the islands of Canaries, Madeira, Azores, Antilles, Bermudas, Shetlands, Hebrides, Orkneys and Iceland. Not one has appeared as far south as the Cape Verd islands.

They show an immense vortex which begins towards the Antilles and Central America with the Gulf Stream, which issues from the Gulf of Mexico, and with the equatorial current ; passing the banks of Newfoundland at a tangent, it turns to the east, approaches the European coasts, and runs southward from the Channel to Gibraltar, after having sent a branch which runs along the coast of Ireland and the coast of Norway as far as the North Cape.

It then returns to the west, encircling the Canaries. Its centre oscillates somewhere to the south-west of the Azores.

My observations enabled me also to establish a very good average for the speed at which these floats have been travelling in the different sections of the vortex, and for every twenty-four hours.

Between the Azores, France, Portugal and the Canaries : 5·18 miles.

From the Canaries to the Antilles, the Bahamas, and as far as the Bermudas : 10·11 miles.

From the Bermudas to the Azores : 6·42 miles.

The mean speed for the North Atlantic is 4·48 miles. These values being under rather than over the truth.

When I began to work on the bottom of the sea to study animal life, as constant sounding is required for that purpose, I found that most of the sounding machines in use were defective, and I had one constructed according to my own ideas. It is completely automatic in all the details of its action, so as to allow a single man to take a sounding at any depth ; the line that I have used for four years is no longer a steel wire, but a steel cable made up of many very thin wires ; it is, therefore, stronger and more pliable. It is paid out at the required speed, hauled up again, dried, greased, and regularly rolled up on a drum by an automatic guide. The brake is a powerful spring.

Among the observations for which this machine is wanted, I will mention those concerning the temperature of the water at different levels. I am using, to obtain them, a thermometer designed for my cruises by Mr. Chabaud, a French instrument maker. It is very much like Negretti and Zambra's pattern, but the part of the tube containing the mercury reservoir is recurved so as to prevent the mass of this metal forcing itself by its own weight through the constricted angle which serves to break the column ; and such an accident used to happen now and then.

When I went into the study of the density of the water, I found that Buchanan's bottle was the best for collecting samples of the stratum nearest to the bottom. But to obtain samples at any intermediate depth, Dr. Jules Richard, chief of my laboratory, has designed a thoroughly trustworthy instrument with which we have been able to study the gases contained in these samples, and to demonstrate that they are not dissolved in the depths at any other pressure than they are at the surface. This instrument can be shortly described by saying that it is a bottle filled with mercury, and inverted with its neck dipping into a dish also full of mercury. In this position it is sent along a steel cable as far as the required depth, where it meets a platform, and where a mechanical action raises the neck of the bottle over the mercury of the dish. The mercury of the bottle then runs out into the dish, and water takes its place. Soon after this, a messenger sent from the ship reaches the instrument, and acts so as to dip again the neck of the bottle into the dish containing the whole of the mercury. In this last position the instrument can be hauled up without any risk of the sample of water being mixed with outside water ; and if there was any gas dissolved in it at a high pressure (which was not the case in my observations), it would gather on the surface of the sample, as this pressure would diminish as the instrument came nearer to the surface of the sea. This research led Dr. Richard to announce in 1895 the presence of argon in the swimming bladder of certain fishes.

Very soon after this, I had the satisfaction of presenting the French Academy of Science with very interesting observations made by M. Knudsen during the cruises of the Danish steamer *Ingolf*. This investigator proved by analyses of samples of water made *in situ* that predominance of animal or vegetable life in any part of the sea causes the variations in the amount of contained oxygen or carbonic acid.

One of the most difficult questions to investigate is the penetration of light in the depth. Photographic plates turned towards the heavens have been exposed by Hermann Fol, and impressed as deep as about 200 fathoms. I have myself used, as far as about 90 feet, an instrument invented by Dr. Regnard for my experiments ; it is a cylindrical box with a narrow slit in the direction of its length. Inside is a sensitive paper, which

is made to pass slowly under the slit by means of clock-work, capable of running for twenty-four hours. If there is any light falling on it, it is shown on the paper when developed, and with the increasing or the decreasing power before or after noon. But by this method one obtains no absolute information, as some more sensitive matter may be discovered any day.

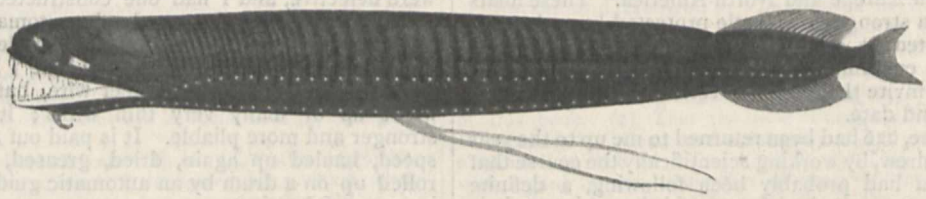

FIG. 3.—*Photostomias Guernei.*

Indeed, light exists everywhere in the depths: where the rays of the sun do not reach themselves, numbers of animals furnish it by special phosphorescent organs which are real accumulators of light. Besides, I have found animals with perfect eyes at every depth; and science teaches us that an organ always atrophies or disappears when the conditions are such as to prevent its use.

Among the special circumstances created by the statical and dynamical conditions of this space, organic life presents itself under aspects which appear strange to those who are accustomed to its appearance near the

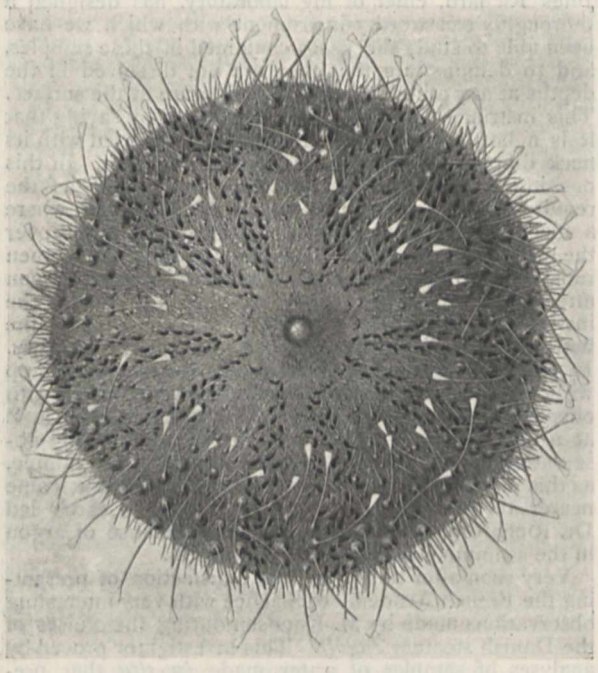

FIG. 4.—*Sperosoma Grimaldii.*

surface. I endeavoured to obtain from all the levels of the sea as many samples of the species belonging to them as it was possible, but I had to find other apparatus than the old trawl used for the former scientific cruises, which can only get animals fixed on the bottom of the sea, or hiding in the mud, or possessing very slow means of progressing. Of course I have used it a great deal, because no other instrument can collect for us a certain fauna; but when it occurred to me that there must be in the deep waters some nimble animals able to escape such a net as a trawl, I first built a trap of a special shape and very large, in order to attract these supposed animals, when properly baited. The trap is lowered to the bottom with a steel cable, and hauled up again after having been left there for a day or two attached to a buoy.

The handling of this was very difficult in the beginning, and required several years' practice to be brought up to positive rules, but it has given most brilliant results, animals quite unknown coming into my hands perfectly well preserved against shocks, frictions and other causes of damage to which they would be liable in a trawl.

One interesting fact they have shown is the enormous

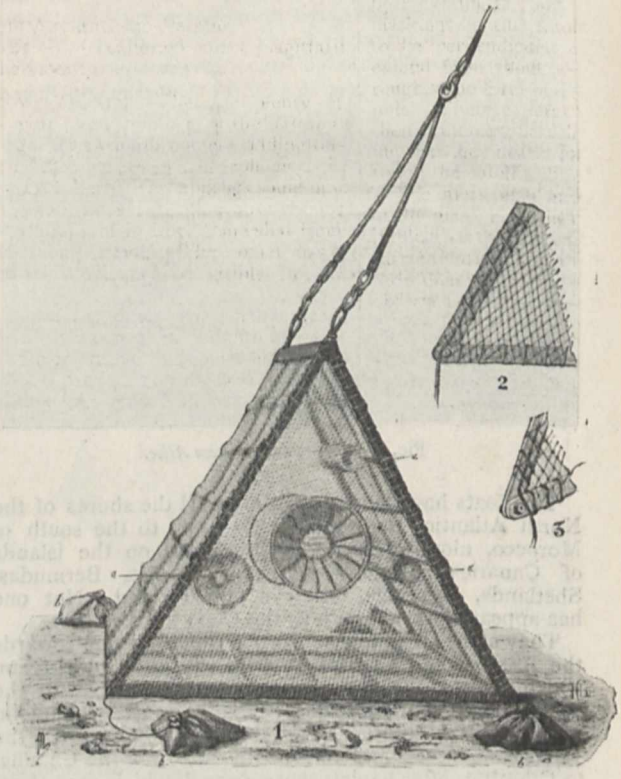

FIG. 5.—Deep-sea trap.

numbers in which some animals exist in certain places. As an example, I obtained one day in a trap that had been lying on the bottom at 700 fathoms depth for twenty-four hours, 1198 fish called *Simenchelys parasiticus*, which was only known by one or two samples in a more or less imperfect state. I have succeeded in sending these traps as low as three thousand fathoms with complete success.

On another occasion my trap brought up a new crab,

one of the largest ever known, *Geryon affinis*, and there were sixty-four specimens of it. Curiously enough, several of them, which had not yet found the entrance of the trap when it was hauled up, made the whole voyage of many hundreds of fathoms, clinging voluntarily to the outside of the trap.

Another time, again (and this was of a special interest because the event took place in the great depths of the Mediterranean, where previous investigations with trawls had led to the supposition that life was almost absent), a trap returned with over eighty sharks called *Centrophorus squamosus*.

For two years I have been trying to use in great depths a net which is very good when used on inshore fishing grounds. This is the trammel; but its use has proved to be exceedingly difficult because of its frailty and its size. Still, I have already obtained with it results which prove how useful it can be. I worked it as low as 1500 fathoms.

The most difficult regions to explore in the sea are the intermediate depths between the surface and the bottom, because the animals living there are very active and very suspicious, and have ample space where they can escape easily, and where they find abundant prey for their food. Besides, the apparatus used must be built in such a manner that they show at what level animals have been caught, or else the scientific conclusion can not be made complete; therefore such an apparatus must be so as to be lowered shut to the determined region, there open and work, and lastly shut again before leaving the region.

Many instruments have been devised for this purpose, but I know only one of them offering complete safety; this is a net invented by Prof. Giesbrecht, which has been slightly altered by Dr. Richard and myself. But it would be difficult to make it of a large size; therefore we get only specimens of very small species.

Lately I have obtained a certain number of large animals living in those intermediate depths and belonging to the very interesting group of cephalopods, by examining the stomach of several cetaceans who feed upon them. Since this interesting fact, I added to the scientific gear of my vessel a complete whaling arrangement. This new method has given me the most remarkable animals of my whole collection; one especially, the *Lepidoteuthis Grimaldii*, can be classified in no actually known species, genus, or even family of his order. It was vomited in 1895, during the dying struggles of a sperm whale, but had unfortunately lost its head by the last adventures of its life. The fragment is about one yard in length, and the complete animal must have measured over seven feet; adding the arms, we get a monster of colossal strength. Its most remarkable feature is a cuirass of large prominent scales which cover its visceral bag; these are quite unknown with animals of that order.

The vomitings of the same sperm whale, who covered two acres of the sea with his blood, contained another immense cephalopod, a Cucioteuthis with arms as strong as a man's, and carrying suckers armed with claws as powerful as those of a tiger; this animal is furnished with luminous organs.

In 1897 another large cetacean, that I was attacking with my whale boats, vomited a large fragment of a cephalopod which was peculiar in being of viscid substance not unlike glycerine; no net could retain it, and we only secured it by "dipping" it up with a large tub as well as the mass of water in which it was floating.

But it will be convenient to remind the reader that cetaceans divide themselves into two principal groups. One, to which belongs the right whale or other marine mammals chased by whalers, and who feed upon very small animals that they absorb simply by moving about with their mouths open. They have no teeth, but a sort of sieve made of what is called whale bone.

Another group, to which belongs the sperm whale, is armed with powerful teeth, a single one weighing sometimes as much as six pounds. They live upon big preys, mostly cephalopods, as aforesaid. These cetaceans are ferocious, while the others have a much milder temper, and some of them, as the *Orca Gladiator*, can be very dangerous to attack. Two years ago I chased a school of three of these, just off the Monaco rock, and very soon one was struck by my whaler's harpoon. While it was ending with violent struggles, the two others came alongside the whale boat and seemed willing to fight for their companion. They swam round and round, sometimes so close that the men touched their enormous backs with their hands. I had to release at once that boat, and for an hour we were (seventeen men and three boats) engaged in a most grand wrestling. The result was that a second orque was killed by a spear stroke.

On the previous day we had caught a grampus, also a cetacean; so we returned to the harbour of Monaco with three of these monsters captured within fifteen miles of that place.

The orques are black and white, much like a magpie, and these were 16 and 18 feet long. They seem to feed

Tail. Lower jaw. Head.

FIG. 6.—Sperm whale being broken up.

exclusively on porpoises. My two, when opened, contained each of them a dozen pieces of porpoise in its stomach like heaps of paving-stones: they had just taken a meal when they were struck.

Among many remarkable facts that I have observed during my studies of the ocean, one has especially called my attention because of its practical consequences; that is, the intensity of life appearing on the surface at certain hours.

Almost in every region of the North Atlantic where I have carried on my investigations, I have ascertained the existence of large tunny fishes which morning and evening chase smaller fishes whose shoals cover sometimes the sea on such a large area that we sail or steam hours and hours across them.

Then, if we sight some wreckage—as a log or a barrel—we always find under it or near it fishes of a good size and of different species that never seem to abandon this guide that they have chosen, and that takes them across the Atlantic. They are very easily caught with a fish spear, and the tunny fish are hooked with a tow-line baited with a rough imitation of a squid.

I once speared in that way fifty fishes weighing 300 pounds altogether, which were following a log on the Atlantic; and their number seemed not to have been much lessened by such a breach. Another day, while I was alongside a log, very anxious to make a good bag, because I had just picked up the crew of an English vessel, the *Blue and White*, sunk under my eyes, and we were already short of provisions, I was disturbed in this occupation by a large shark, who was himself living about the log, and who, after having looked at me with his cruel eyes, stuck himself under my dinghy. His head and his tail projected beyond the ends of this boat, and the friction of his back against the keel gave a rather uncomfortable feeling. Therefore, after I had made a few catches of the usual fishes, which gave him some excitement, I left the log and returned on board, escorted for some distance by the disagreeable wanderer.

On the other hand, we have on many occasions caught dozens of tunny fishes in a day by simply using the aforesaid tow-line.

Thus I can state that many sailors wrecked on the Atlantic, and abandoned for days and weeks on its apparently uninhabited wilderness, have died of hunger among a most abundant and attainable food, and that they could have been saved had they simply known it, and possessed the very simple gear required. Therefore I think that all the principal boats of a ship ought to be permanently provided with a few lines and hooks and with a fish spear.

There is no very obvious explanation of the fascination which any floating or drifting object seems to have for marine animals of various sorts. Even turtles, which are very stupid, and sperm whales or other cetaceans, which seem intelligent, are attracted by a buoy or by a ship, and any kind of apparatus brought up from the depth, even a cable end, is often accompanied by single fish or small companies, which get hopelessly bewildered when the object disappears out of the water.

REPRODUCTION BY PHOTOGRAPHIC PROCESSES.

IT is not difficult to understand the survival and general adoption of those photographic methods in which the light, by shining upon the sensitive surface, produces shading or blackness. Although the first product, as obtained in the camera, by such a process is itself useless as a photograph, the lights and shades being reversed; this "negative," as it is termed, becomes a means of reproduction, as by laying the negative over a sensitive surface more or less similar to that first used, and allowing the light to shine through it, any required number of prints or copies in true light and shade may be obtained. Such a process is necessarily slow, as in working upon this system the production of each individual print or photograph involves an exposure to light, and the rapidity of reproduction is limited by the chemical intensity of that light which is available, and also by the sensitiveness of the material used.

Another system of reproduction, and one which is month by month becoming of greater industrial importance, evades the necessity of a special exposure to light for obtaining each individual print or copy, this being effected by the production of a printing surface or plate from which copies may be printed by mechanical means. Prints obtained by a special exposure to light for each copy are often called solar prints, or true photographs, while those prints which are printed mechanically from a plate or surface which itself is photographically produced, are now so generally called process prints, that the title of "The Process Year-Book"[1] is by no means ambiguous in its meaning to those who are current with the technological phraseology of the day. "The Process Year-Book" well represents the present state of process craft, not only by giving numerous representative illustrations, but by articles from the leading authorities in such matters. The articles are, however—as should be in a work of this kind—written rather for the expert than for the comparative outsider, and we shall give our readers a better general idea of the development and present condition of reproduction by the photo-mechanical processes if we drift away from our text, than if we confine our remarks to the matter before us in Mr. Gamble's volume.

It is interesting to note that the early experiments of Nicéphore Niepce, which were commenced as far back as 1813, were undertaken with the view of obtaining printing surfaces by photographic agency, so the history of photographic process work includes the first chapter in photographic history. Niepce coated lithographic stones or metal plates with a varnish the solid material of which tends to become insoluble in its menstruum where exposed to light. There are many such varnishes, and as an example we may mention a solution of bitumen in a volatile oil like that of turpentine. Those portions of the film which are still soluble after exposure are next dissolved away, while the insoluble portions form a ground, or resist against the etching fluid, which is next used. A heliographic etching on metal by Niepce, made about 1824, is still extant, and in 1827 he brought several specimens to England; but very little attention was given to photographic matters until, in 1839, the daguerreotype was introduced with its perfect rendering of the most delicate degrees of light and shade, and this by a very short exposure in the camera.

Considering that the daguerreotype image is of the nature of a deposit on a smooth metal surface, the idea of moulding by the electrotype process so as to produce an intaglio printing plate, naturally presented itself; as also that of etching the metal, in the hope that the image on the surface might serve as a local resist. Grove, Chevalier, Claudet and others made experiments with the view of obtaining printing plates from the daguerreotype by such methods, but most etchings were wholly unsatisfactory; and although the electrotype casts of the plate were perfect as reproducing in intaglio every tone of the original, the plate had neither that grain nor that depth which are essential to the satisfactory printing of a photo-engraved plate.

Mr. Fox Talbot, whose Calotype or Talbotype process on paper was made public practically at the same time as the daguerreotype, was one of the first to produce satisfactory intaglio printing plates, and his method is specially interesting as being the basis of that process of intaglio photogravure which is most in use at the present time. Talbot coated the metal plate with a wash or film of gelatine made sensitive to light by the addition of bichromate of potassium, and he exposed under a transparent positive. Where the light acted to the full, the gelatine became impervious to aqueous fluids; but where protected from the light, the film allowed such fluids to pass readily, and between these extremes were all degrees of intermediate resistance to the passage of the aqueous etching fluid. Talbot used such saline etching materials as platinic chloride or ferric chloride, and from time to time he suggested and used various methods of producing an ink-holding grain, such as a resinous dust, a network, or a kind of aqua-tint ground formed by the evaporation of a solution of camphor and common resin in chloroform. The chief present-day method of photogravure is Herr Klic's modification of the Talbot method, the chief differ-

[1] "The Process Year-Book, a Review of the Graphic Arts." Conducted by William Gamble. (London and Paris: Penrose and Co.)

ence being that the film of chromated gelatine, hardened by the action of light, which forms a resist to the etching fluid, is transferred to the metal plate after being exposed; a proceeding which affords one very important advantage. The gelatine, which remains soluble or unaffected by light, can under these circumstances be washed away by warm water, leaving on the metal plate a resist of graduated thickness. The frontispiece of "The Process Year-Book" for last year is a very fine example of photogravure by the Talbot-Klic process, the work of Mr. Horace Wilmer; a specimen interesting as showing that, in process work, the amateur may stand fully level with the professional. The frontispiece of the current issue (1898) is a good specimen of similar work by Dr. E. Albert of Munich.

Printing by hand from the intaglio plate is a very slow process, especially in the case of the finer class of work; and although we gather from "The Process Year-Book" that very much progress has recently been made in the rapid printing of intaglio plates by machine, the chief or general aim of the process-worker now-a-days is the rapid production of plates or blocks which can be set up with a forme of type, and printed together with the type and without any complication of the method of printing.

Methods of making such photo-typographic blocks are very numerous, but according to that system of working which is now most general, the first and most delicate task is to obtain a negative in which the degrees of transparency are rendered by the increasing size of minute windows ranged in regular order all over the subject; but where the negative is most opaque the size of each of these windows may be reduced to *nil*, and where the negative is most transparent the windows may run into each other and give an area of virtually clear glass. Such a negative is obtained if a glass plate or screen, closely ruled with opaque cross-lines, is set in the camera a little way in front of the sensitive plate, each window in the screen forming a pin-hole image of the aperture of the lens. The question of the best use of the ruled screen and the most suitable kind of ruling is a very complex one, as evidenced by several very recondite articles in "The Process Year-Book." The screen-negative having been obtained, an impression is made on a metal plate coated with a sensitive resist, which sensitive resist may be bitumen, sensitive albumen, or, more often in practice, the highly soluble and almost gum-like gelatine sold as fish glue. Each window of the screen negative makes an insoluble spot of corresponding size on the sensitive film, after which the soluble portions of the film are dissolved away, and the insoluble spots of graduated size form the resist in the next stage: etching the plate. When sufficiently etched, the plate is ready for being printed from, and it naturally gives an impression in which each window of the screen-negative is rendered by a dot of printing ink of corresponding size.

There are many other methods of photographic process reproduction in use, and still more methods which have been worked out experimentally but have not yet obtained any commercial status. As regards the application of three-colour heliochromy to process work, we need say no more than to remark that any method of process reproduction may be applied to the formation of the triad of printing surfaces from which it is necessary to print in true register with appropriate pigments; and the question of the successful application of heliochromy to process work depends rather on the colour-sensitising of the negative films, the use of appropriate colour-screens and of suitable printing pigments, than on the purely process side of the work. Those wishing to learn more, or to see representative examples of results, cannot do better than to obtain "The Process Year-Book."

T. BOLAS.

THE FORTHCOMING MEETING OF THE BRITISH ASSOCIATION.

THE following epitome of the programme of the forthcoming Bristol meeting of the British Association has been prepared by the Local Secretaries. We have already given a provisional list of the excursions, and shall supply our readers with further details as soon as the routes are finally settled and the arrangements complete.

Tuesday, September 6.—The Cabot Tower, on Brandon Hill, will be opened at 3 p.m. by the Marquess of Dufferin and Ava, K.P., G.C.B.

Wednesday, September 7.—Drill Hall Exhibition opened at 3 p.m., by the Marquess of Dufferin and Ava, K.P., G.C.B. Address by the President, Sir William Crookes, F.R.S., in the Colston Hall, at 8 p.m.

Thursday, September 8.—The Biological Exhibition at the Zoological Gardens, Clifton, will be opened at 3 p.m. by Sir John Lubbock, Bart., M.P. Garden party given by Mr. and Mrs. W. M. Roscoe, at Crete Hill, Westbury-on-Trym, 3.30 to 6 p.m. (200). Garden party, given by Mr. E. P. Wills and Miss Wills, at Hazlewood, Sneyd Park, 3.30 to 6 p.m. (200). Conversazione, at Clifton College, given by the Chairman of the Council (the Lord Bishop of Hereford), the Head Master and Mrs. Glazebrook, 8.30 to 11.30 p.m.

Friday, September 9.—Garden party, given by Mr. and Mrs. Frank Jolly, at Rockwell, Henbury, 3.30 to 6 p.m. (100). Garden party, given by Mr. Lewis Fry, M.P., and Miss Fry, at Goldney House, Clifton, 3.30 to 6 p.m. (300). Garden party, given by Mr. J. Colthurst Godwin and Miss Godwin, at Ellenthorpe, Stoke Bishop, 3.30 to 6 p.m. (200). Lecture by Prof. W. J. Sollas, F.R.S., on "Funafuti: the Study of a Coral Island," in the Colston Hall, at 8 p.m. "Symposium," in honour of the President, Sir William Crookes, F.R.S., at the Merchant Venturers' Technical College, at 10 p.m. (limited to 250).

Saturday, September 10.—Excursions. Lecture to working men, by Prof. E. B. Poulton, F.R.S., "The Ways in which Animals Warn their Enemies and Signal to their Friends," in the hall of the Young Men's Christian Association, at 8 p.m. Public banquet, arranged by the President and members of the Bristol Chamber of Commerce, at the Colston Hall.

Sunday, September 11.—Special sermons by the Lord Bishop of the Diocese (Cathedral, 11 a.m.), Prof. Bonney (Redcliffe Church, 6.30 p.m.), and Rev. D. Richards, 11 a.m., and Rev. John Gerard, S.J., 6 p.m. (Pro-Cathedral, Park Place, Clifton). The band of the Royal Artillery (mounted) will perform a selection of music at the Drill Hall, at 3 p.m.

Monday, September 12.—Garden party, given by the headmaster and assistant masters of Clifton College, 3.30 to 6 p.m. Lecture by Mr. Herbert Jackson, on "Phosphorescence," in the Colston Hall, at 8 p.m.

Tuesday, September 13.—Garden party, given by Mr. and Mrs. Edward Robinson, at The Towers, Sneyd Park, 3.30 to 6 p.m. (200). Garden party, given by Mr. and Mrs. G. A. Wills, at Burwalls, Leigh Woods, 3.30 to 6 p.m. (200). Conversazione at the Colston Hall, given by the Local Committee, 8.30 to 11.30 p.m.

Wednesday, September 14.—Concluding general meeting, in the Lecture Theatre, Bristol Museum, at 2.30 p.m. Garden party, given by Mr. and Mrs. Herbert Ashman, at Cook's Folly, Sneyd Park, 3.30 to 6 p.m. (200).

Thursday, September 15.—Excursions.

Friday, September 16 to 20.—Excursion through Devonshire, extending over five days. Exeter, Torquay, Dartmouth and Plymouth have taken up the matter very warmly, and kindly offers of hospitable entertainment have been received from them.

The Committees of the leading Clubs in Bristol and Clifton have consented to grant the privilege of honorary membership to visiting members of the Association during the meeting.

NOTES.

THE centenary of the Paris Conservatoire des Arts et Métiers was celebrated on Friday last. The Priory of Saint-Martin-des-Champs, where the collections of the Conservatoire are installed, contains fourteen thousand exhibits. Seventeen professors hold evening classes in the building, and there are eight laboratories, one of photography and photometry being a recent addition. The Academy of Sciences has on several occasions presented objects of scientific interest to the museum of the Conservatoire, among them being its collection of machines, physical apparatus, and part of the contents of Lavoisier's laboratory.

THE programme of the fourth International Congress of Zoology, to be held at Cambridge in August, has been issued. The meeting will open on Monday, August 22, with a reception at the Guildhall by the Mayor of Cambridge. On the following day, the formal opening of the Congress and election of officers will take place in the morning, and the Sections will meet in the afternoon. The Sections will be: (*a*) General Zoology; (*b*) Vertebrata; (*c*) Invertebrata (except the Arthropoda); (*d*) Arthropoda. On Wednesday, August 24, there will be a general meeting of the Congress to discuss the position of sponges in the animal kingdom. The discussion will be opened by Prof. Yves Delage, of Paris, and Mr. Minchin, of Oxford. On Thursday a general meeting will be held to discuss the origin of Mammals. The discussion will be opened by Prof. H. F. Osborn, of New York, and Prof. Seeley, of London. The Sections will meet on Friday, August 26, and on Saturday a general meeting will be held to settle the time and place of the fifth International Congress.

WE notice with regret the announcements of the deaths of two distinguished botanists: Prof. Anton Kerner, Ritter von Marilaun, professor of systematic botany in the University of Vienna, and Prof. Ferdinand Cohn, professor of botany in the University of Breslau.

THE tenth Congress of Russian Naturalists and Physicians will be held at Kieff on August 21–30, under the presidency of Prof. J. Rachmaninow.

M. E. A. MARTEL, whose researches in underground caverns have often been referred to in these columns, has been created a Chevalier of the Legion of Honour.

AT the annual general meeting of the Royal Statistical Society, held on Tuesday, it was announced that the subject of the essays for the Howard medal, which will be awarded in 1899, with 20*l.* as heretofore, is "The Sentences on, and Punishments of, Juvenile Offenders in the Chief European Countries and the United States." The essays should be sent in on or before June 30, 1899.

A DESTRUCTIVE earthquake was experienced in some parts of Italy on Monday night. The shock was felt all along the Antrodoco valley, and several buildings were thrown down in the commune of Santa Rufina. The disturbance was felt at Rieti shortly after midnight.

CAPTAIN SVERDRUP'S polar expedition on board the *Fram* left Christiania on Friday morning.

A REUTER telegram from Tromsö reports that Mr. Walter Wellman, the American explorer, left on Monday on board his ice steamer *Frithyof* for the North Polar regions. Just before his departure from England Mr. Wellman gave to Reuter's representative an account of his expedition, in which he said that his aim was to reach the North Pole, and also to explore the still unknown northern parts of Franz Josef Land. The party consists of Prof. James H. Gore, Columbia University, a geodesist; Lieut. Evelyn B. Baldwin, who was on the Greenland ice cap with Lieut. Peary; Dr. Edward Hofma, naturalist and medical officer; and Mr. Quirof Harlan, physicist, from the United States Coast and Geodetic Survey. Norwegians experienced in Arctic work make up the remainder of the party of ten. Mr. Wellman proposes to reach the Pole by a sledging expedition over the pack ice.

THE Geologists' Association have arranged an excursion to Birmingham from July 28 to August 3, under the direction of Prof. C. Lapworth, F.R.S., Prof. W. W. Watts, Mr. W. J. Harrison, and Mr. W. Wickham King. A sketch of the geology of the Birmingham district, with special reference to this excursion, will be given at the meeting of the Association to-morrow, July 1.

MR. WALTER E. ARCHER, Inspector of Salmon Fisheries under the Fishery Board for Scotland, has been appointed Chief Inspector of Fisheries to the Board of Trade, in succession to Mr. A. D. Berrington, who has retired. On Mr. Berrington's retirement, the Fisheries Department and the Harbour Department of the Board of Trade have been combined into one department, which will be called the Fisheries and Harbour Department, and will be under the charge of the Hon. T. H. W. Pelham, as Assistant Secretary.

THE death is announced of Dr. Charles E. Emery, the well-known American engineer. Dr. Emery was a member of the Institution of Civil Engineers, and received a Watt medal and Telford premium for a paper in which he described the plant constructed by him at New York for the house-to-house distribution of steam raised in a central boiler. He was a prominent member of the principal American engineering societies, and was president of the New York Electrical Society in 1896-97. He also held the post of non-resident professor of the Cornell University.

THE Committee appointed to consider the present state of the law with regard to the storage, transport, and sale of petroleum have decided to recommend Parliament to raise the legal flash-point of oil from 73° F. to 100° F. It is believed that comparatively few lamp accidents will occur when the use, as an illuminant, of oil with a flash-point below 100° F. is forbidden; but unless the suggested legislation also provides against the construction and sale of lamps with glass reservoirs and of faulty design, the raising of the flash-point of the oil burned in these lamps will only partly prevent the accidents.

THE annual general meeting of the British Institute of Preventive Medicine was held on Friday, June 24, at Chelsea. The meeting was attended by the Duke of Westminster, Earl of Feversham, Lord Lister, Dr. Pye-Smith, Dr. Thomas Bridgwater, and others. The Report states that during the year the work of the Institute has been marked by progression and expansion. The internal fittings of the new building are in an advanced state, some departments are already in full operation, and it is confidently anticipated that all will be fully equipped in the early autumn. The demand for diphtheria and streptococcus serum has increased, and there has also been an increased demand for mallein and tuberculin. The Institute has rented laboratory accommodation to the Local Government Board for the purpose of preparing glycerinated calf lymph. The volume of *Transactions*, published by Messrs. Macmillan and Co. on behalf of the Institute, contained nine original contributions by members of the staff. A number of fresh investigations have been conducted and completed during the year; some of these are published, and others are on the eve of publication. There are also other investigations in progress, and the laboratories continue to attract research workers. The Institute has endeavoured to encourage the periodical examination of water

and water supplies, and several local authorities have requested the Institute to undertake this systematic examination on their behalf. Bacteriological work has also been undertaken for several additional sanitary authorities. In the new building every facility is being provided for the furtherance of bacteriological research. The Institute will require, however, a considerable addition to its funds to enable it to carry out adequately the objects for which it was founded.

THE preliminary programme of the sixteenth Congress of the Sanitary Institute, to be held in Birmingham, from September 27 to October 1, has now been issued. The President of the Congress is Sir Joseph Fayrer, Bart., K.C.S.I., F.R.S. Dr. Christopher Childs will deliver the lecture to the Congress, and Dr. Alex Hill, Master of Downing College and Vice-Chancellor of Cambridge University, will deliver the popular lecture. Excursions to places of interest in connection with sanitation will be arranged for those attending the Congress. A conversazione will be given by the Right Hon. the Lord Mayor (Councillor C. G. Beale), and a garden party, at the Botanical Gardens, Edgbaston, will be given by members of the Sanitary Committee. It appears from the programme that over three hundred authorities, including several County Councils, have already appointed delegates to the Congress, and, as there are also over two thousand members and associates in the Institute, there will probably be a large attendance in addition to the local members of the Congress. In connection with the Congress, a Health Exhibition of apparatus and appliances relating to health and domestic use will be held as a practical illustration of the application and carrying out of the principles and methods discussed at the meetings; which not only serves this purpose, but also an important one in diffusing sanitary knowledge among a large class who do not attend the other meetings of the Congress. The Congress will include three general addresses and lectures. Three Sections will meet for two days each, dealing with (1) Sanitary Science and Preventive Medicine, presided over by Dr. Alfred Hill; (2) Engineering and Architecture, presided over by Mr. W. Henman; (3) Physics, Chemistry, and Biology, Dr. G. Sims Woodhead. There will be five special conferences: Municipal Representatives, presided over by Alderman W. Cook; Medical Officers of Health, presided over by Dr. John C. McVail; Municipal and County Engineers, presided over by Mr. T. de Courcy Meade; Sanitary Inspectors, presided over by Mr. W. W. West; Domestic Hygiene, presided over by Mrs. C. G. Beale (the Lady Mayoress). The local arrangements are in the hands of an influential local Committee, presided over by the Right Hon. the Lord Mayor of Birmingham, with Prof. A. Bostock Hill, Mr. W. Bayley Marshall, and Mr. J. E. Willcox as Honorary Secretaries.

DR. G. VAILATI, writing in the *Bolletino di Storia e Bibliografia Matematica*, has brought to light an obsolete book of Euclid dealing with balances and the principle of the lever. This work has become known through an Arabic translation by Ibn Musa in the National Library at Paris, an account of which was given in 1851 by Woepke in the *Journal Asiatique*, but seems to have been overlooked by mathematicians. Euclid's reasoning is based on the two axioms: (1) that if a loaded lamina balances about a horizontal axis, it will continue to balance when the weights are displaced parallel to the axis; (2) if a lamina balances horizontally about two intersecting axes in its plane, it will also balance about their point of intersection. From these axioms, Euclid deduces a proposition *practically* equivalent to a special case of the theorem that three equal weights placed at the vertices of a triangle will balance about a median. Then by the first axiom a second proposition is proved, virtually amounting to the statement that a single weight on one side of a lever will balance two equal weights on the opposite side if the distance of the first from the fulcrum is equal to the sum of the distances of the second and third. By the superposition of such sets of equilibrating systems, and the removal of pairs of weights symmetrically placed on opposite sides of the fulcrum, Euclid arrives at the conditions of equilibrium on a lever whose arms are in the ratio of two whole numbers by a method closely analogous to that adopted by Archimedes.

DR. ADRIEN GUÉBHARD, of St. Vallier-de-Thiey, sends us a number of papers dealing with the supposed photographic representation of currents emanating from the human body, concerning which much appears to have been said in France a few months ago, when the subject was brought into prominence by the announced discoveries of Dr. Baraduc and the late Dr. Luys. Briefly told, when a slightly fogged photographic plate is developed in a shallow bath, and the experimenter presses his fingers on the plate during the process, streaks are observed to radiate from the parts touched. So far from the effect being due to "animal magnetism," or any of the other occult influences with which spiritualists are wont to deal, Dr. Guébhard shows that the lines are simply caused by convection currents produced by the warmth of the operator's finger. If for the latter there be substituted a small india-rubber ball filled with warm water, exactly the same impressions are produced. Similar results are obtained with a body cooled below the temperature of the developer, and in each case their intensity is greater the greater the difference of temperature. In some of Dr. Guébhard's figures the lines closely resemble the lines of flow due to sources and sinks, or the lines assumed by iron filings in the presence of magnets; as representations of the lines of flow of convection currents, these figures may interest the physicist.

WE have received a copy of the observations made at the Blue Hill Meteorological Observatory, Massachusetts, during the year 1896, forming Part i. vol. xlii. of the *Annals* of the Astronomical Observatory of Harvard College, containing results of observations made at three stations as in former years. The primary station is the observatory on the summit of Great Blue Hill, at an elevation of 640 feet above mean sea-level, and the two secondary stations are situated north-west of it, one being at the base of Blue Hill. In addition to the usual meteorological tables and hourly cloud observations and measurements of heights and velocities recommended by the International Meteorological Committee, the work contains an interesting study of special cloud forms and their relations to cyclones and anticyclones, as well as to other phenomena, by A. E. Sweetland. One of the principal features of the work of the observatory is the exploration of the air by means of kites. A full description of the methods employed is given by S. P. Fergusson, and a valuable discussion of the records by H. H. Clayton. This exploration was begun in August 1894, and is, we believe, the most thorough study of the lower strata of free air ever made, and occasionally very high altitudes are also attained. We are glad to see that the continuance of the useful observations at Blue Hill, now maintained by the liberality of Mr. A. L. Rotch, has been assured by the leasing of the land around the observatory by Harvard College, and that it is expected that the work will uitimately become a part of that carried on directly by that University.

VARIOUS schemes have from time to time been suggested for utilising the power of the tides and waves as a motive force, and ingenious models have been constructed showing the various methods proposed. The plans consist generally either of a system of reservoirs for storing the water at high tide and using it by means of water-wheels or turbines as the tide falls, or else by compressing air in a chamber and making use of its expan-

sion in working an engine. None of these schemes have, however, so far been carried into practical effect. On one or more tidal creeks in this country there have, however, existed water-wheels for grinding corn worked by the tides. Across the creek self-acting doors are placed which open to let the tide flow up, and automatically close as soon as it begins to recede. For several hours each tide there is thus afforded a supply of water with sufficient head to work a water-wheel which turns the machinery. Recently, at Los Angeles, an attempt has been made to make use of the waves. At the end of a pier 350 feet long, three floats were constructed acting on hydraulic air compressors connected with storage tanks holding water situated at different levels. By means of the compressed air the water is driven from a lower into a higher tank, which affords the head required to work a water motor. The waste water from the motor flows back again into the lower tank, to be again raised by the compressor. The varying effect of the waves is compensated by this arrangement of air and water pressure. The experiment is said to have proved sufficiently satisfactory to warrant the extension of the system so as to develop 200 horse-power.

IT is seldom that military operations afford much opportunity for scientific research, but the Ashanti expedition of 1896 was fortunately an exception. Upon the recommendation of Kew, Surgeon-Captain H. A. Cummins accompanied the expedition as a member of the medical staff, and he succeeded in bringing back a collection of about two hundred species, including nine which were new, and one new genus. A list of these plants, with their geographical distribution and descriptions of the new species, and notes on the physical and botanical characters of the country traversed by Surgeon-Captain Cummins, appears in the latest issue of the *Kew Bulletin* (Nos. 136–137). The economic products of the region from Cape Coast Castle to the Moinsi Hills, which are 150 miles inland, are numerous. "Plantains are largely grown, and form the principal food of the inhabitants. Indian corn is extensively cultivated and grows freely. Sugar-cane is grown in many of the villages. Pine-apples are found all over the country in such a way as to lead persons who have travelled far inland to believe them indigenous. Cola, rubber and gum trees grow plentifully in the forest region, and are reported to be more numerous in the districts around Kumassi." In addition to these plants, there are many trees producing valuable wood in great quantity. The country is unhealthy, but Surgeon-Captain Cummins states that if a railway penetrated the forest zone, establishing a rapid means of communication with the healthy mountainous interior, trade in the vegetable and mineral products of the country could be carried on without the present limitations.

ANOTHER interesting article in the *Kew Bulletin* is a brief account of the principal botanical museums in Belgium and Holland, by Mr. J. M. Hillier, assistant in the museums of the Royal Gardens. A noteworthy preservative solution, consisting of alcohol with the addition of two per cent. of hydrochloric acid, was found in use at the University Botanic Garden, Ghent. The object to be preserved is placed in this solution for a few weeks according to discretion, after which it is put into methylated spirit for permanent preservation. In the Commercial Museum at Brussels scientific names are not as a rule attached to the products, but useful details are given on the labels with regard to prices, &c. Mr. Hillier describes Prof. Errera's process for preserving flowers and other objects in their natural colours. "The specimen to be preserved is placed in a conical-shaped paper bag, the narrow diameter resting in the mouth of a glass jar. The bag is carefully filled up with finely sifted sand, after which the jar, together with its contents, is kept at a warm even temperature for two or three weeks, at the expiration of which time the sand is carefully removed and the dried specimen placed in a stoppered jar. The stopper must be hollow and filled with unslaked lime, the latter being kept in position by a thin piece of leather tied over the portion of the stopper which is inserted into the mouth of the jar. The lime absorbs all moisture, and so preserves the specimen from deterioration by damp."

MR. FRANK FINN, Deputy Superintendent of the Indian Museum, contributes a number of interesting notes on natural history to the *Proceedings* of the Asiatic Society of Bengal. Much remains to be done in the observation of living birds, even when these belong to quite common and well-known species. Mr. Finn's notes on peculiarities of attitude, &c., of various birds are, therefore, very useful contributions to ornithology. In a note on the position of the feet of the "Picarian" birds and of parrots in flight, he concludes from his experiences that "supposing the same habit of carrying the feet to run through a family, the forward position of the feet in flight probably characterises hoopoes, woodpeckers, and barbets, and the backward one certainly obtains among kingfishers, rollers, hornbills, cuckoos, and parrots." In other notes Mr. Finn describes various species of Grebes, with especial reference to the power of walking and digestion possessed by these birds; brings forward an instance which confirms the common belief in India that the whip-snake has a propensity for deliberately striking at the eye; and shows that the Indian Gossander can walk like other ducks, and does so in the same attitude. Such notes as these, on imperfectly known points in the habits and economy of birds, are of distinct service to students of avian classification.

MESSRS. W. WESLEY AND SON, Essex Street, Strand, have issued a Catalogue (No. 131) of works on gardening in all its branches, reaching to 714 publications.

WE have received the reports, for 1896 and 1897, of the Botanical Department of the Indiana Agricultural Experiment Station, by Mr. J. C. Arthur, State botanist, including an account of experiments on the cultivation of various agricultural crops and garden flowers.

FROM the Government Laboratory, Antigua, we have received a report of the results obtained on the Experimental Fields, at Skerrett's School, 1897. It refers almost entirely to the cultivation of the sugar-cane, especially to the relative values of different varieties, and to the diseases to which the cane is subject, and the remedies for them.

MESSRS. SEALY, BRYERS, AND WALKER, of Dublin, announce for early publication Mr. H. Chichester Hart's "Flora of Co. Donegal, with Introduction on Topography, Geology, Geographical Distribution, &c., and Appendices on Plant Names and Plant Lore and Climate."

THE Department of Agriculture, Victoria, has issued a brochure of additions to the fungi on the vine in Australia, by Mr. D. McAlpine, Government Vegetable Pathologist, assisted by Mr. G. H. Robinson. It includes a very full account of twenty-three species, fourteen of which are parasitic and nine saprophytic fungi, ten of them being new to science. The report is very copiously illustrated.

IN *Bulletin* No. 1 of the Geological Survey of Western Australia, Mr. A. Gibb Maitland, Government Geologist, gives a bibliography of the works, papers, reports, and maps bearing upon the geology, mineralogy, mining, and palæontology of the Colony. The publications are arranged in alphabetical order under authors' names.

THE tenth issue of "The Wealth and Progress of New South Wales," by Mr. T. A. Coghlan, bringing the affairs of the Colony up to the end of 1897, has just been distributed by the Agent-General for New South Wales. The volume contains more than a thousand pages, and is filled with accurate information of service to persons who are engaged in the active life of the Colony, and not without interest to those who are not concerned about the details of local affairs. It would be to the credit of all our Colonies if they published such admirable life-histories as the one for which Mr. Coghlan is responsible.

THE first volume of a second edition of a useful directory of German makers of optical instruments, and other instruments of precision, has been published by the firm of F. and M. Harrwitz, Berlin. This "Adressbuch" is edited by Herr F. Harrwitz, the editor of the journal *Der Mechaniker*, and has been greatly enlarged. It contains the names and addresses of German mechanicians, opticians, glass instrument makers, and allied callings, arranged alphabetically according to names of firms, towns, and specialities. How numerous these makers of scientific instruments are in Germany may be judged from the fact that the directory just issued contains nearly four hundred pages.

THE number of the *Journal of the Royal Microscopical Society* for June contains a reference by the President, Mr. E. M. Nelson, to an old book on optics, Zahn's "Oculus Artificialis," published in 1702. The following figures, taken from the work, are reproduced in the *Journal*:—A telescope-sight for a musket and a cannon, with the legend: "Bombardae et omni genere balistarum ac tormentorum bellicorum tubum opticum sive telescopicum aptare, quo visus ad scopum exactè dirigi poterit." A sunshine recorder or "Organum heliocausticum," with the legend "Horas Luce Sono tibi sphaerula Vitrea monstrat, ignis nil mirum Coelicus urget opus." A series of mirrors for a telescope called "Catoptrico dioptrica telescopica." The same number of the *Journal* contains a lengthy abstract of Dr. A. Clifford Mercer's important paper on "Aperture as a Factor in Microscopic Vision," delivered as a presidential address to the American Microscopical Society; also an abstract of Mr. E. M. Nelson's paper on "Microscopic Vision," read before the Bristol Naturalists' Society; and the commencement of a series of papers by Mr. Fortescue W. Millett on recent Foraminifera of the Malay Archipelago, collected by Mr. A. Durrand, illustrated by plates.

AMONG the volumes lately published by W. Engelmann, Leipzig, in Ostwald's valuable series of reprints and translations of scientific classics (*Klassiker der exakten Wissenschaften*) is a translation, with notes, by Herr W. Abendroth, of Newton's first book on optics, dealing with reflection, refraction, and colour, Four of Ernst von Brücke's papers on plant physiology, published between 1844 and 1862, are reprinted in No. 95 of the series; and a paper, translated from the Swedish of Eilhard Mitscherlich (1821), on the relation between the chemical composition and crystalline form of salts of arsenic and phosphorus, forms No. 94. The article on crystallography and crystallometry, contributed by J. F. Christian Hessel to Gehler's *Physikalische Wörterbuche* in 1830, appears as a reprint in Nos. 88 and 89, edited by Herr E. Hess. Prof. Ernst von Meyer edits No. 92, containing a paper by H. Kolbe (1859) on the natural connection of organic with inorganic compounds, and its bearing upon the classification of organic bodies. No. 90 is a translation from the French of a geometrical paper (1848) by A. Bravais; and No. 91 is a German edition of a paper by G. Lejeune Dirichlet (1839-40) on various applications of infinitesimal analysis to the theory of numbers.

THE value of the Reports of the U.S. National Museum has been so often referred to in these columns, that the announcement of the publication of a new volume containing a report upon the condition of the Museum and the work accomplished in its various departments, is sufficient to convey to all who are familiar with the Smithsonian Reports the fact that a large amount of information has been added to the pabulum of scientific readers. The Report just issued runs into 1080 pages, is lavishly illustrated, and is full of interesting matter. In an elaborate paper, Dr. Franz Boas describes and illustrates the collections of the Museum referring to the social organisation and secret societies of the Indians of the coast of British Columbia. His paper is based upon personal studies made during a series of years, and forms a very valuable contribution to the ethnology of the Kwakiutl Indians. Many brilliant reproductions of photographs taken during the performance of native ceremonies are given, and also the transcriptions of a series of phonographic records of songs belonging to the ceremonials. "The Graphic Art of the Eskimos" is dealt with by Dr. W. J. Hoffmann in another long and well-illustrated essay, which will interest archæologists as well as anthropologists. In addition to the researches in pictography, the paper contains much information upon the gesture language of the various tribes studied. A comparison of the pictographs, and various painted records found in different parts of the United States, with the Eskimo work, show the latter to be superior to the former, especially in faithful reproduction of animal forms and delicacy of artistic execution. The remaining papers in the volume are much shorter than the two already mentioned. Among the subjects dealt with are the tongues of birds, taxidermical methods in the Leyden Museum, and the antiquity of the Red Race in America.

SINCE the memorable researches of Humphry Davy on the decomposition of the alkaline earths, many methods have been suggested for preparing the metal calcium in the pure state. M. Moissan, in the current number of the *Comptes rendus*, after showing that none of these yield a pure metal, describes two ways of preparing crystallised calcium containing less than one per cent. of impurities. The first of the methods depends upon the property possessed by calcium of dissolving in liquid sodium at a dull red heat, and separating out in crystals on cooling. By treating the mass cautiously with absolute alcohol the sodium is removed, and the calcium is obtained in the form of brilliant white hexagonal crystals. Similar white crystals of calcium can be obtained by the electrolysis of fused calcium iodide. It is noteworthy that calcium has usually been described by previous workers as a yellow metal; doubtless owing to the presence of impurities.

THE additions to the Zoological Society's Gardens during the past week include a Sykes's Monkey (*Cercopithecus albigularis*, ♀) from West Africa, presented by Miss Gladys Carey; a Macaque Monkey (*Macacus cynomolgus*, ♂) from India, presented by Miss Stankowski; a Brush-tailed Kangaroo (*Petrogale penicillata*, ♂) from Australia, presented by Mr. C. J. Leyland; two Red-backed Pelicans (*Pelicanus rufescens*) from the River Niger, presented by Mr. H. S. Bernstein; a Black Hangnest (*Cassidix oryzivora*) from the Amazons, presented by Mr. R. Phillipps; two Yellow-cheeked Lemurs (*Lemur xanthomystax*), two Madagascar Tree Boas (*Corallus madagascariensis*) from Madagascar, a Banded Ichneumon (*Crossarchus fasciatus*), an Angulated Tortoise (*Testudo angulata*) from Africa, a Blue-fronted Amazon (*Chrysotis æstiva*) from Brazil, six Algerian Tortoises (*Testudo ibera*) from Algeria, deposited; a Great Ant-eater (*Myrmecophaga jubata*), a Tamandua Ant-eater (*Tamandua tetradactyla*) from South America, a Green-winged Trumpeter

(*Psophia viridis*) from the Amazons, two White-necked Storks (*Dissura episcopus*) from Africa, two Dusky Francolins (*Pternistes infuscatus*) from British East Africa, a Madagascar Tree Boa (*Corallus madagascariensis*) from Madagascar, purchased; two Red and Yellow Macaws (*Ara chloroptera*) from South America, received in exchange; a Hybrid Zebra (between *Equus caballus*, ♂, and *Equus burchelli*, ♀), a White-tailed Gnu (*Connochætes gnu*, ♂), two Thars (*Hemitragus jemlaica*, ♂ ♀), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN JULY:—

July 3. 8h. 57m. Partial eclipse of the moon. Magnitude 0·934.
4. Wolf's comet due at perihelion.
13. Venus 1° north of α Leonis (Regulus).
15. Venus. Illuminated portion of disc 0·765.
15. Mars. ,, ,, ,, 0·904.
15. Jupiter. Polar diameter, 31″·9.
15. Saturn. ,, ,, 16″·6.
16. 6h. 31m. to 9h. 25m. Transit of Jupiter's Sat. III.
18. 8h. 7m. Annular eclipse of the sun invisible at Greenwich.
18. Wolf's comet 27′ distant from Mars.
19. Saturn. Outer minor axis of outer ring, 17″·89.
26. 22h. 0m. Mercury nearly occults α Leonis (Regulus).
28. 12h. 49m. Moon in conjunction with α Scorpii (Antares).
28. Many meteors from Aquarius and Perseus.
30. 7h. 31m. to 8h. 41m. Occultation of λ Sagittarii (mag. 3·1) by the moon.

COMETS THAT ARE NOW VISIBLE.—There is plenty of cometary news in the three most recent numbers of the *Astronomische Nachrichten* (3498–3500). As regards comet Coddington-Pauly, which has a declination too southern for the ephemeris to be of any use in this column, Prof. Berberich publishes some new elements (*Astr. Nach.*, No. 3500) based on other observations than those previously used by him, which differ somewhat from the values given in his first computation. The comet has a southerly movement, so that it will not be visible in our latitude.

Comet Perrine (June 14), on the other hand, has a great northerly declination, and is increasing in brightness very rapidly. The elements and ephemeris of this comet have been computed by Perrine and Aitken, and also by Berberich. The elements obtained by the former we published last week, but they differ slightly from those calculated by Berberich, these being as follows:—

T = 1898 August 4·7473 Berlin M.T.

$$\left.\begin{array}{rl} \omega = & 235\ 16'77 \\ \Omega = & 252\ 2'34 \\ i = & 72\ 11\ 43 \end{array}\right\} 1898{\cdot}0$$

$\log q = 9{\cdot}44405$

The ephemeris for the current week, according to these values, is:—

Ephemeris for 12h. Berlin M.T.

1898.	R.A. (app.) h. m. s.	Decl. (app.) ° ′	log r.	log Δ.	Br.
June 30	5 4 3	+52 57·9			
July 1	9 56	52 23·3	9·9817	0·2061	2·34
2	15 46	51 46·9			
3	21 34	51 8·7			
4	27 19	50 28·7			
5	33 1	49 46·7	9·9415	0·1904	3·03
6	38 40	49 2·7			
July 7	5 44 15	+48 16·7			

The new comet discovered by Giacobini is gradually decreasing its southern declination, but the elements at present calculated are described as uncertain. With a diameter of 2′, an excentric condensation, and of about the 10th magnitude (June 21), the comet is not an easy object. Those wishing to observe it will find the following positions useful.

Ephemeris for 12h. Berlin M.T.

1898.	R.A. (app.) h. m. s.	Decl. (app.) ° ′	Br.
June 29	18 5 48	−21 36·2	1·35
July 3	17 8 1	19 28·6	1·22
7	16 20 13	16 47·2	1·01
11	15 43 37	−14 11·4	0·79

THE FIRST SATELLITE OF JUPITER.—In two early numbers of *Astronomy and Astrophysics* (November 1894 and May 1893) our readers may remember that Prof. W. H. Pickering contributed an account of a very interesting series of observations on the shapes of the satellites of Jupiter, and the conclusions he arrived at were that the discs were by no means round, but assumed very decided irregularities as they performed their rotations. These satellites have been further minutely examined by Mr. A. E. Douglass during last year, and in the *Astronomische Nachrichten* (No. 3500) he describes what knowledge has been gained by the observations of the first satellite. These were made in Mexico, from February 18 to March 28, with the Clark 24-inch, and in Flagstaff from May 16 to June 9. We must confine ourselves to a very brief summary of this paper, and refer our readers to the original for the minute details given both in the text and accompanying plate.

Although the markings on the satellite were sometimes well seen, the observations were not numerous enough over a long period of time to effectively map and determine the period of rotation by tracing the succession of detail. Mr. Douglass adopted Prof. Pickering's method of observing the changes in the elliptical form of the satellite's disc. After an elaborate trial of several periods he was led to deduce a period of 12h. 25·8m. for the year 1897, a value not very different from that found by Pickering in 1892, namely 13 hours. Most peculiar are the markings on this satellite. Assuming the axis of the satellite to be perpendicular to the plane of its orbit, they appear to extend from about + 60° to − 60° in latitude, and they take roughly the form of lines directed either to the north or south pole. Their general distribution can be best described and their symmetry best illustrated, as Mr. Douglass says, "by saying that they nearly form portions of five great circles passing round the satellite."

The micrometer measures for determining the elliptical form of the disc gave indications of a large ellipticity. Mr. Douglass thinks that this flattening is real, and not due to the presence of surface markings near the limb. The following brief table shows the values of the ellipticity and period of rotation for the periods observed since 1892:—

Date.	Ellipticity.	Period. h. m.	Obs.	Telescope
Dec. 1892	100–110	13 3	Pickering	13 inch
Oct. 1894	108–120	13 3	,,	18 inch
March 1895	104–120	(?)	Douglass	,,
March 1897	115–130	12 25·8	,,	24 inch

The indications of an increase in the ellipticity and decrease in the period of rotation led Mr. Douglass to investigate the question of whether a decrease in the size of the disc had been observed. An examination of the existing measures showed that such a change has probably taken place, but the values cannot be relied on for certain. If this decrease in size be an actual fact, then the increase in rotational velocity and increase in mean polar compression would naturally follow.

THE METEOR SHOWER OF NOVEMBER 13, 1897.—Those who intend to systematically observe or photograph the meteor shower next November, will find in the account of the arrangements made last year at the Harvard College Observatory (*Annals*, vol. xli. No. 5) many interesting suggestions. Prof. W. H. Pickering, as will be gathered from his description in the above-mentioned *Annals*, made arrangements for a combined attack on the night of the 13th at various stations connected with the observatory. To present an idea of the scale in which such work is undertaken in America, in addition to visual observations, we give the number of plates exposed and instruments used. Three plates were taken with the Draper 11-inch telescope, with two objective prisms of 15°. Fourteen plates with the 8-inch, with two objective prisms of 6° each. Twelve plates with the 6-inch, with objective prism of 6°. Eight plates with a Voigtländer 5-inch, with an objective prism of 6°. Three plates with a Ross rapid rectilinear lens of 1·5 inch, angle of prism 15°. With such a collection of fine instruments at work, it was only too disappointing that the meteors were so few and faint;

but it is consoling to think that the experience gained that night will undoubtedly be used to render the work at the time of the next November meteor shower more efficient. As regards the best form of lens to employ, Prof. Pickering advocates "a portrait lens of the kind formerly used by photographers." The plates should be exposed for half an hour, and at the end of this time the camera should be again pointed to the region fifteen minutes preceding the radiant point. At the Solar Physics Observatory, at Kensington, the methods employed were to fix a camera on the tube of a large equatorial (near the object-glass end), and also on the hour-angle circle of a siderostat, both cameras being moved by the clock-work of each instrument. Other cameras were fixed and oriented towards the radiant point and other directions. The 9-inch equatorial with objective prism was also used, but no bright meteor, unfortunately, passed across the field. May the meteorological conditions be such that the meteor shower of November 1898, will be well observed and successfully photographed!

HIGH SPEED TELEGRAPH TRANSMISSION BY MEANS OF ALTERNATORS.

ALTHOUGH, at the present day, high speed transmission is much more limited in its application than at an earlier period in the history of telegraphy, owing to the commercial aspects of the question having been unavoidably altered, attempts have been made from time to time to produce improvements in this direction; but until lately the admirable system invented by the late Sir Charles Wheatstone, and considerably improved by the British Post Office Telegraph Administration, has been the best available method of automatic high speed signalling.

The speed at which a series of waves can be passed over a given line depends primarily and inversely upon the product of the total resistance into the total capacity, the form of the wave having a considerable influence on the speed where any measurable capacity is present.

In the ordinary Wheatstone automatic fast speed system of telegraphy, the letters are formed by waves of different duration, a dot being produced by a short wave, a dash by a longer one. This renders it necessary to charge the line longer for a dash than for a dot, which is a grave defect in fast speed working; but the condenser compensation, introduced and employed by the British Post Office, practically doubles the speed attainable on any given line by, in some measure, equalising the line charges. That is to say, the condenser used is always of a capacity which admits of a full charge during the time interval of a dot, and a current of the duration of a dash does not give the condenser any higher charge. Indeed condenser compensation has such a beneficial effect, that the defect of unequal impulses is almost overcome, inasmuch as the increase of speed obtained by this arrangement and equal impulses, is only 5 per cent. greater than that obtained with currents of unequal duration. Again, although the signals be made equal in this system, another difficulty presents itself; that is, the waves that are sent through the line are the results of the sudden applications of the full E.M.F. used (in practice 100 volts), and consequently a reversal means a sudden change of 200 volts, *i.e.* from 100 volts positive to 100 volts negative. The form of the current wave with such a system depends almost entirely on the nature and form of the circuit. It is easy to produce correspondingly sudden and complete changes in the current when the circuit possesses only resistance, but when capacity, &c., is present, the form of current wave is vastly different to the impressed E.M.F. wave; for example, take the letter "A," the actual current curve on a land line without condenser compensation is shown in Fig. 1, while Fig. 2 represents the effect of shunted condenser compensation.

Prof. A. C. Crehore, of Dartmouth College, U.S.A, in conjunction with Lieut. G. O. Squier, of the United States Artillery, have, however, been led to make some experiments with alternators, and have suggested a mode of high speed signalling which, although presenting some mechanical difficulties, has recently been tried by the inventors of the Post Office telegraph lines in England, under the direction of Mr. Preece, and found to produce a distinct increase of speed.

Fig. 3 shows an ordinary sine wave as produced by an alternator, and it is this form of wave that Messrs. Squier and Crehore use in their so-called "synchronograph" system of fast speed telegraphy.

The signals are obtained by the omission of certain complete cycles or semi-cycles, the message being read by means of the blanks in the regular succession of recorded dots; or signals can be recorded on chemically prepared paper.

This system is to some extent a synchronous one with this great advantage over the many well-known synchronous systems, that the synchronism is not required between the transmitter at one end and the receiver at the other end of a line, but between the alternator and transmitter at the sending end of the line. This is easily obtained by driving the transmitter from the generator shaft. The transmitter itself is exceedingly simple, and consists of a wheel the circumference of which is one continuous conductor, presenting a smooth surface for the brushes to bear upon. If the periphery of this wheel be divided into forty equal parts, and be geared to run at one-fourth the speed of the armature of a ten-pole alternator, clearly one of these equal parts will correspond to one semi-cycle of E.M.F. produced by the alternator. Upon the surface of the wheel bear two

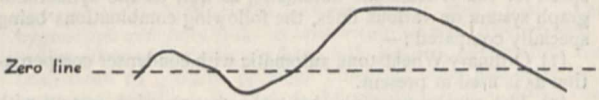

FIG. 1.

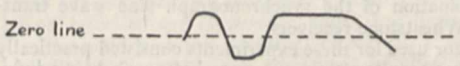

FIG. 2

brushes, carried by an adjustable brush-holder. One brush is joined to the generator, and the other to the line, so that the current entering one brush from the generator passes across the transmitting wheel to the other brush, and thence out to the line.

Now if a piece of paper $\frac{1}{40}$ of the circumference of the wheel be fixed thereon in such a position as to pass under one of the brushes, one semi-cycle or half-wave of current will be omitted in every twenty complete waves, and by means of a suitably prepared paper ribbon, or "slip," any combination of signals can in this simple manner be transmitted. The brushes are adjusted so that the periods of disconnection and connection coincide with the zero points of E.M.F. The transmitter may, however, have only one brush joined to line, and the wheel itself may be made the connection to the generator. With this mode of signalling much higher E.M.F.s may be used, and connections and disconnections made almost without spark at the brush contacts.

The speed of the transmitting wheel with respect to the generator shaft is immaterial, the essential being that its circumference should contain an integer number of times the arc which a point fixed with respect to the field would describe on such circumference during one semi-period of current.

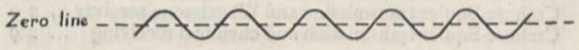

FIG. 3.

Complete control of every semi-cycle of current thus permits the maximum speed of transmission of signals with a given frequency. If the transmitter does not act in synchronism with the generator, the "make" and "break" of the circuit occurs when the current is not naturally zero, and considerable interference results; care is, therefore, taken to ensure that the "slip" admits of the line connections being made at the proper times only.

Athough the received signals were originally intended by Messrs. Squier and Crehore to be recorded on chemically prepared paper, they have also devised a very ingenious massless receiver, although at present it is not in a practical form. It is based on the well-known discovery of Faraday that a beam of polarised light may be rotated by means of a magnetic field, the direction of rotation of the ray being the same as the direction of the current producing the field; the rotary power depends upon the intensity of the magnetic field, and the total amount of rotation upon the length of the rotary medium in which this magnetic field exists and through which the ray passes.

The method adopted is to pass a beam of light through a

Nicol's prism, thence through a long tube with plane glass ends containing liquid carbon bisulphide, and afterwards through a second Nicol's prism. The ray of light is received on a screen having a sensitised surface, which is carried forward at an uniform speed; a long coil is wound round the tube containing the carbon bisulphide, the prisms being adjusted so that no light passes through the tube when no current is flowing through the coil, the source of light being an arc lamp.

The passage of a current rotates the polarised ray within the tube, and the light then falls on the sensitised screen, and is thereby recorded.

As neither of these methods of reception are suitable for every-day use, the British Post Office undertook, in conjunction with the inventors, a series of valuable and interesting experiments over the departmental lines under more practical conditions. The existing departmental records of capacity, resistance and mileage, compiled for the whole country, proved invaluable by supplying exact data for each of the experiments performed, and enabled reliable tables and curves to be constructed. The experiments consisted of determinations of the highest limits of speed for the Wheatstone automatic, as well as the synchronograph system on various lines, the following combinations being specially compared:—

(1) Ordinary Wheatstone automatic with condenser compensation as is used at present.

(2) The synchronograph sine wave transmission system with chemical receivers.

(3) A combination of the synchronograph sine wave transmission with Wheatstone receivers.

The alternator used for these experiments consisted practically of several separate alternators on one shaft, each being independent of the remainder, and so constructed that, with the same speed of revolution, different frequencies or wave speeds could be obtained; transformers being used in those cases where it was desirable to maintain the E.M.F. unaltered.

Careful estimations were made not only of the force employed, which is about 50 per cent. higher than that ordinarily used on Wheatstone circuits, but also of the wave speed, and its equivalent value in "words per minute" in each case.

On a line from London to York and back, mainly composed of copper, having a total mileage of 431½, and a K.R. equal to 33,000, a speed of 540 words per minute was attained with Wheatstone receiver and Crehore-Squier transmitter (synchronograph), although the maximum limit was not reached. The speed obtainable with this K.R. being only 360 when ordinary Wheatstone automatic was used.

From London to Aberdeen and back, with a total mileage of 1097½ and a K.R. of 261,000, a speed of 135 words per minute was obtained by the Crehore-Squier Wheatstone combination, as compared with 46 words per minute on the ordinary Wheatstone automatic with the best compensating arrangements.

These two cases are typical of the whole series of observations, which enabled the comparative wave speeds of the different systems to be estimated as follows:—

Wheatstone automatic alone	1
Crehore-Squier transmission and Wheatstone receiver ...	2·9
Crehore-Squier transmission and chemical receiving ...	2·9

In the first two cases the number of waves necessary for each word is of course the same, but in the last-named case, where chemical receiving is employed, a further gain is obtained by using fewer waves for each word, making the word speed in the three cases bear the ratio 1, 2·9 and 7.

Chemical receiving is by no means so convenient as ordinary Wheatstone, and the most pressing practical requirement at the present day is not higher speeds for short distances, but higher direct working speeds over long lines where at present intermediate "repeaters" are necessary.

It is satisfactory to note that the maximum wave speed attainable by synchronograph transmission with the chemical receiver or with the Wheatstone receiver is exactly the same on any circuit where the speed is limited by the line itself and not by the receiving apparatus.

On the Wheatstone system shunted condensers are necessary to compensate for two distinct effects—the unequal duration of the signals, and the inductance of the receiver. Where the synchronograph transmission is employed on short cables or open lines, no line compensation is required, and a fixed condenser can be shunted across the receiver coils so as to compensate for the inductance of the receiver for any given speed. In connection with this question the inductance of the Post Office receiver was carefully verified, and was found to be 3·46 Henrys, the necessary condenser compensation depending solely on the speed of transmission (or wave-frequency) and the arrangement of the receiver coils, and in no instance having any direct or complicated relation to the line capacity.

On an artificial cable, equal to about 200 miles of ordinary submarine cable, where condenser compensation is used at both ends, the increase of wave speed obtained by the synchronograph was only 50 per cent. instead of 190 per cent. as in the case of open wires. It would therefore appear that with further experiment some line compensation might be found to be necessary for cable working.

The experiments show that where the capacity of the line is not great, as in the case of aerial lines, the transmission of the current in sine waves produces the best results, and leaves the factor of the inductance of the receiving instrument to be dealt with separately, and consequently in a more exact manner.

The principal difficulty in the application of the system is the necessity for the use of a new code of signals, or a reduction in the speed value to admit of conformity with existing codes. The existing Wheatstone automatic instruments are also light, portable, and adapted for use in outlying districts at short notice, where the synchronograph would probably be found to be less suitable. The perforator at present in use for the preparation of the transmitting "slip" has also, by a process of evolution, become extremely convenient, and equally suitable for hand working in confined spaces, or where power is available.

A suitable and easily manipulated perforator for the synchronograph has yet to be devised. Messrs. Squier and Crehore, however, deserve great credit for the discovery, with limited means of experiment, of an improved and promising system of high speed transmission.

OBSERVATIONS ON STOMATA.[1]

THE method described depends on the fact that in adult leaves transpiration is stomatal rather than cuticular, so that, other things being equal, the yield of watery vapour depends on the degree to which the stomata are open, and may be used as an index of their condition. In principle, it is the same as the methods of Merget (*Comptes rendus*, 1878) and Stahl (*Bot. Zeitung*, 1894). These observers used hygroscopic papers impregnated with reagents which change colour according as they are dry or damp, and Stahl, who employed paper soaked in cobalt chloride, has obtained excellent results. In my laboratory I have used, for some years, a hygroscope for demonstrating cuticular transpiration, in which evaporation is indicated by the untwisting of the awn of *Stipa pennata* (Darwin and Acton, "Practical Physiology of Plants," 1st edition, 1894); my present instrument is of the same general type, but the index is made of "chinese leaf," *i.e.* shavings of pressed and heated horn.[2] If a strip of horn is placed on a dry substance, *e.g.* the astomatal surface of a leaf, it does not move, but on the stomatal surface it instantly curves strongly away from the transpiring surface. In the hygroscope the degree of curvature is read off on a graduated quadrant, and in this way a numerical indication of the condition of the stomata is obtained.

The instrument makes no claim to accuracy, but has proved extremely useful when used comparatively to indicate and localise small changes in the transpiration of leaves, and therefore, by implication, changes in the condition of the stomata. By observing under the microscope the uninjured leaf of *Caltha palustris*, and comparing the variations in the size of the stomata with the variations in the readings of the hygroscope, it is easy to convince one's self of the value of the method. It must be especially noted that though a fall in the hygroscope readings corresponds with a narrowing of the stomatal opening, it does not follow that zero on the hygroscopic scale means absolute closure of the stomata. This want of sensitiveness has one advantage, namely, that cuticular transpiration has no effect on the horn index, so that any movement of the index

[1] A paper by Francis Darwin, F.R.S., read at the Royal Society, June 16.

[2] I also use the epidermis of a *Yucca*—a material which I owe to the kindness of Mr. Thiselton-Dyer.

must depend on a stomatal transpiration. The hygroscope indicates well the gradual "closure"[1] of the stomata that occurs as a plucked leaf withers. It is generally stated that marsh and aquatic plants do not close their stomata under these circumstances. I find that, although the phenomenon is much less marked than in terrestrial plants, yet that, in many species, partial closure of the stomata undoubtedly occurs in the aquatic class.

The most interesting fact observed in withering leaves is that in many cases the "closure" of the stoma is preceded by temporary opening, which may occur almost simultaneously with the severance of the leaf from the plant. Thus the hygroscope readings rise at first, and subsequently sink to zero. The interest of this fact is the demonstration of the interaction between the guard cells and the surrounding epidermis. The phenomenon is best seen in plants with milky juice, but is not confined to this class. The preliminary opening of the stomata occurs in the early morning, but not in the evening—a fact which is of importance in relation to the mechanism of the nocturnal closure of the stomata.

A diminution of the stomatal transpiration can also be brought about by compressing the stem of the plant in a vice, a process which is known to diminish the water supply (F. Darwin and R. Phillips, *Camb. Phil. Soc. Proc.*, 1886). The stomatal closure is here probably an adaptive response to the lowering of the water-supply of the leaf, but this is not quite certain.

A series of experiments were made on the comparative effect of moist and dry air, from which it is clear that the stomata "close" before any visible signs of flaccidity occur in the leaf. When leaves are exposed to air dried by H_2SO_4, "closure" is preceded by a remarkably prolonged opening of the stomata—a phenomenon which requires further investigation.

Baranetzky (*Bot. Zeitung*, 1872) showed that slight degrees of disturbance affect transpiration. The hygroscope gives no evidence of increased transpiration when the disturbance is slight. When the plant is violently shaken the leaves become flaccid and the stomata "close," and in some cases the closure is preceded by increased transpiration, no doubt due to temporary opening of the stomata, induced by the guard cells being released from epidermal pressure before they have lost their own turgor.

N. J. C. Müller (Pringsheim's *Jahrbücher*, vol. 8, 1872) showed that stomata may be closed by electric stimulation; my experiments show that while a strong shock narrows the stomata, a weaker one opens them, no doubt owing to the temporary loss of epidermal pressure.

Some experiments on poisonous gases and vapours were made. Chloroform and ether slowly "close" the stomata, which finally reopen in a normal atmosphere. Pure CO_2 also slowly closes the stomata.

The hygroscope is well fitted to demonstrate the fundamental facts in relation to light. The fact that the stomata are widely open in sunshine is well known; the difference between bright and less bright diffused light is not so well known, nor the fact that in dark stormy weather the stomata may be nearly closed by day, even in summer. The effect of difference of illumination is well shown in certain leaves having stomata in both surfaces, *e.g. Iris*, *Narcissus*, and the phyllodes of *Acacia cyclopis*. In these the stomata on the illuminated surfaces are much wider open than on the less brightly illuminated sides; and when the plant is reversed in position in regard to light, the stomata rapidly accommodate themselves to the change in illumination.

The most interesting fact in regard to the effect of artificial darkness is that it is more effectual in producing closure in the afternoon than in the morning; and, conversely, illumination opens closed stomata more readily in the morning than later in the day. These, together with other observations, tend to show a certain amount of inherent periodicity in the nocturnal closure of the stomata. Another fact of interest is that in darkness prolonged for several days the stomata gradually open. This last observation is used in the section on the mechanism of the stoma as an argument against the prevalent view that the stoma closes in darkness, because in the abeyance of assimilation the osmotic material, on which the turgor of the guard cells depends, ceases to be manufactured.

Schellenberger (*Bot. Zeitung*, 1896) has striven to uphold this view by showing that in the absence of CO_2 the stomata close as though they were in darkness. My experiments on plants deprived of CO_2 lead to absolutely contrary results, namely, that the stomata remain perfectly open even during prolonged deprivation of CO_2.

It is a vexed question (Leitgeb, *Mittheilungen aus dem Bot.*, Inst. zu Graz, 1886) whether or no the majority of plants close their stomata at night. My conclusion is that in terrestrial plants (excluding nyctitropic plants) a great majority show some closure at night; the horn hygroscope stands at zero on the stomatal surface of by far the greater number of ordinary plants. On the other hand, the hygroscope shows widely open stomata on most aquatic plants at night. Stahl (*Bot. Zeitung*, 1897) concludes that nyctitropic plants are remarkable for not closing the stomata at night; this fact I somewhat doubtfully confirm; but the question is not so simple as it seems, owing to the varying behaviour of the stomata at night in different temperatures.

Since the hygroscope gives numerical readings it is possible to represent graphically the daily opening and closing of the stomata. The curve begins to leave the zero with the morning light; it rises rapidly at first, and afterwards more slowly. In some cases it runs roughly horizontally until a rapid fall begins in the evening. In other cases there is a slow rise up to the highest point, which occurs between 11 a.m. and 3 p.m. The hygroscope generally sinks to zero within an hour after sunset.

The effect of heat has not been fully studied, but enough has been done to confirm previous observers who find that heat opens the stomata. As regards the visible spectrum, I find that the red rays are decidedly most efficient, but I am not able to find any evidence of a secondary maximum in the blue, such as Kohl (*Bieblatt zur Leopoldina*, 1895) describes.

The biology of the nocturnal closure is a subject which can hardly be discussed in a condensed manner. It is suggested that the gaseous interchange of assimilation may require widely open stomata, whereas respiration may be carried on with comparatively closed apertures. If this is so, the stomata might be to a great extent shut at night, and an economy in the use of water effected, without detriment to metabolism. Observations are given to show that quite another effect is brought about by nocturnal closure. As long as the stomata are open, the transpiring leaf is considerably cooler than the dry-bulb thermometer, but at night it has almost the temperature of the air. In this way a saving of heat is undoubtedly effected—but it is not easy to say whether it is sufficient to be of much practical importance to the plant. I am inclined to believe, from Sachs' (*Arbeiten*, 1884) experiments on the depletion of leaves, that all saving of heat must be valuable, by preventing the checking of translocation which he observed.

The mechanism of the stoma is another subject which does not lend itself to condensed treatment. I have tried to point out that the stoma has been neglected in the modern reorganisation of plant physiology from the point of view of irritability. Some observers insist on the preponderant influence of the guard cells, while Leitgeb in the same way exaggerated the importance of epidermic pressure, whereas the two factors should, as far as possible, be considered as parts of a whole and as correlated rather than opposed in action. I have also attempted to show how the stoma, like other parts of the plant, may be supposed to react adaptively to those signals, which we usually call stimuli. The attempt which I have made to rank the problem among the phenomena of irritability, is very tentative in character. I have ventured to put it forth because I am convinced that it is in this direction that advances will be made.

[1] I use the word "closure" to mean such a narrowing of the stomatal aperture as corresponds with zero on the hygroscope.

A NEW PHOTOGRAPHIC PRINTING PAPER.

ACTING as agents for the Nepera Chemical Co., New York, Messrs. Griffin and Co., of Garrick Street, have for some time been issuing a new sensitised paper under the name of "Velox," which for ease of manipulation and perfection of results promises to take a firm hold on public favour. From its advent, something more than a year ago, there has been ample opportunity to test the most desirable quality of a photographic paper, viz. its permanence under varying conditions, and, at the least, it can be relied on as much as any *silver* sensitised paper.

Full instructions for the manipulation of the paper for various purposes are given with it, and they do not greatly differ from those employed in the use of other bromide papers. The

special advantages claimed for this paper is that the several difficulties involved in the working of ordinary papers are removed. The chief simplification is in the fact that a dark room may be entirely dispensed with, all operations being performed in an ordinary room lit in the usual manner. The paper is described as being coated with a chloro-bromide emulsion, and it is owing to the extreme slowness of this that a special non-actinic illumination is unnecessary. Of course, care is wanted, and *direct* light should not be allowed access to the print; but in an ordinary room, lit by two windows at middle of day, perfectly clean whites may be obtained by turning the back to the window, and developing in the shade thus produced.

Again, no great amount of apparatus is required, not even a printing frame; development is very efficiently performed on a sheet of glass, applying the developer with a pledget of cotton-wool or a mop camel-hair brush.

The exposure for contact printing from an average negative varies from 1–3 seconds for diffused daylight, to 30–120 seconds to a gas-burner at 6 inches distance. A point that might with advantage be added to the instructions for use, is the great convenience of magnesium ribbon as an illuminant. This is being brought forward by many leading plate and paper makers, and deservedly so. The light of burning magnesium is one of the most intense illuminants at present known; and as a great part of the light is concentrated in the blue and violet regions of the spectrum, the parts most effective on a silver emulsion, this gives the light a high efficiency. From 1–3 inches of ribbon, burnt at from 8–12 inches distance, will be found to give satisfactory exposures. Another point in favour of using magnesium is the ease of firing it, all the extra articles needed being a box of matches.

It might be worth while to make the gelatine, &c., which forms the basis of the emulsion, more insoluble than it appears to be from the samples tested, as many people find it convenient to dry prints quickly, and if the paper has not been specially treated, there is danger of blisters or of complete melting of the film. The paper is obtainable in several varieties of surface and suitability for different purposes.

Another suggestion, not mentioned in the circular issued, may perhaps be made as likely to extend its popularity. It is that the paper may be toned with any of the usual toning baths for bromide paper, the one made with copper sulphate and potassium ferricyanide, giving reddish-brown tones, being very suitable.

One of its good qualities is the ease of maintaining pure whites; and this will no doubt lead to its extensive use for copying purposes, as both the negative and positive may be made on the paper. For scientific workers, as well as pictorial photographers, the paper will doubtless prove a great boon.

From its extreme simplicity of manipulation, moderate price, and general high quality, the paper ranks high among silver emulsion printing papers.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. RICHARD ABEGG, privat-docent in physical chemistry at Göttingen, has been promoted to the rank of professor; Dr. Oswald Lohse, observer in the Potsdam Astrophysical Observatory, has also been promoted to a professorship; Dr. Böhmig, privat-docent in zoology at Gratz, has been appointed assistant professor; Prof. Kalkowsky, of the Technical High School in Dresden, has been appointed director of the geological and prehistoric museum there.

ON Wednesday in last week, the Duke of Devonshire opened the new Christie Library at the Owens College, Manchester, and laid the foundation of the Whitworth Hall, another addition to the college buildings. The library is the gift of Mr. R. C. Christie; and the expense of erecting the Whitworth Hall will be met by the sum of 50,000*l.* received by Mr. Christie as one of the residuary legatees of the estate of the late Sir Joseph Whitworth, and since paid by him to the Treasurer of Owens College.

IT is but rarely that an issue of *Science* appears without the announcement of one or more gifts to educational and scientific institutions in the United States, or for the advancement of learning. The following are among the donations recently announced:—By the will of the late Dr. Elizabeth H. Bates, of Port Chester, N.Y., the University of Michigan will receive 125,000 dollars, the income from which is to be used in establishing a chair for the diseases of women and children, to be known as the Bates professorship.—The will of the late Mrs. Annie S. Paton, of New York, leaves 100,000 dollars to Princeton University, subject to an interest for life of her two sons. The bequest is to found a fund for an endowment for Paton lectureships in ancient and modern literature.—It is said that Mrs. Phœbe Haarst will erect a building for mining engineering for the University of California at a cost of 300,000 dollars.—A building for the College of Agriculture of Ohio State University has been completed during the present year at a cost of 70,000 dollars.—The will of the late Mr. Felix R. Bonnet, of Pittsburg, Pa., provides that, upon the death of his widow, 300,000 dollars shall go to the Western Pennsylvania University for the endowment of scholarships.—A donor, whose name is withheld, has subscribed 25,000 dollars for Barnard College in case the 100,000 dollars needed to liquidate the debt on the College are subscribed by October 3. 23,000 dollars had previously been subscribed.—Hobart College, Geneva, N.Y., has received 6000 dollars for a scholarship by the will of Mrs. Augusta M. Williams.—Mr. Philip D. Armour has given an additional endowment fund of 500,000 dollars to the Armour Institute of Technology, Chicago. He had previously given the Institute an endowment of 1,500,000 dollars.—Mr. Washington Duke has given 100,000 dollars to Trinity College, Durham, N.C., which makes the total amount of his gifts to the College 425,000 dollars.—Dr. D. K. Pearsons, who has assisted so many smaller colleges, has offered to give the Salt Lake College, of Salt Lake, Utah, 50,000 dollars, on condition that its officers raise 100,000 dollars more within a year.—Dr. George W. Hill has been appointed lecturer in celestial mechanics in Columbia University, Miss Catherine W. Bruce having given 5000 dollars for this purpose.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 26.—"On the Kathode Fall of Potential in Gases." By J. W. Capstick, M.A., D.Sc., Fellow of Trinity College, Cambridge. Communicated by Prof. J. J. Thomson, F.R.S.

Hittorf and Warburg have shown that when an electric current passes through a tube containing a gas at a pressure of a few millimetres, the fall of potential along the greater part of the tube varies with the pressure of the gas and the current strength, but in the immediate neighbourhood of the kathode there is a fall which is constant in amount provided the negative glow does not cover the whole electrode, or extend to the walls of the tube. It seems likely that this kathode fall will prove to be connected with other constants of the gas, and the aim of the present investigation was to find such a connection by measuring the kathode fall in a compound gas and its constituent elementary gases. The gases used were water vapour, ammonia, and nitric oxide and their constituents.

No difficulty was experienced in measuring the fall in the elementary gases, and the separate readings for any one gas showed good agreement. It proved, however, a very difficult matter to get a constant current to pass through the compound gases. Many months were spent in a fruitless attempt to find what conditions determine the constancy of the current, and since the kathode fall is not constant when the discharge is intermittent, very few measurements could be made on the compound gases.

The values in volts ultimately found for the kathode falls were as follows:—

Hydrogen	298
Nitrogen	232
Oxygen	369
Water vapour	469
Ammonia	582
Nitric oxide	373

Warburg had previously determined the fall in hydrogen and nitrogen. For the former, he found 300. For atmospheric nitrogen containing argon, he found 232. The present experi-

ments were made on nitrogen prepared from ammonium nitrite, whence it appears that the presence of argon does not affect the kathode fall.

The value found for nitric oxide is of very doubtful validity. The appearance of the discharge showed that the gas is rapidly decomposed, and the fact that the kathode fall is nearly the same in nitric oxide, air and nitrogen with a trace of oxygen, points to the oxygen being the sole carrier of the electricity in each case.

If we leave nitric oxide out of account, it appears that the kathode fall is an additive quantity, and hence a property of the atoms rather than of the molecules.

Assuming that the conduction in gases is electrolytic, the analogy of the electrolysis of liquids suggests the possibility that the kathode fall is a measure of the heat of dissociation of the gas. If this be the case, the experiments might be taken to support J. J. Thomson's view that the carriers of the current are provided by the disintegration of the atoms into much smaller particles.

June 9.—"Experiments on Aneroid Barometers at Kew Observatory and their Discussion." By C. Chree, Sc.D., LL.D., F.R.S.

The paper deals with two species of data. The first consists of particulars derived from the records of Kew Observatory as to the errors in aneroid barometers subjected to the ordinary Kew test, which consists in lowering the pressure to which the aneroid is exposed inch by inch to the lowest point required, and raising the pressure in a corresponding way to its original value. Readings are taken at each inch of pressure during both the fall and the recovery, and a table of corrections is obtained by reference to a mercury gauge.

The second group of data are the results of special experiments made at Kew Observatory during the last three years.

The aneroid is an instrument exhibiting elastic after-effect. When pressure is lowered and then maintained constant, the reading continues to fall, and when pressure is restored to its original value, the aneroid reads at first lower than it did originally, but exhibits a tendency to recover. The most characteristic features were discussed thirty years ago by Dr. Balfour Stewart. They have also been the subject of a pamphlet by Mr. Edward Whymper, who gives the results of a number of interesting long period experiments.

The present paper treats of how the differences between the readings with pressure descending and ascending in a normal pressure cycle, such as the Kew test, varies throughout the range, and how the sum of these differences varies from one range to another. It investigates how the error, as pressure is reduced, varies with the rate of fall of pressure (when uniform), how the fall of reading at a low stationary pressure increases with the time, depends on the pressure, and varies with the rate of the previous fall of pressure, and how the recovery after a pressure cycle progresses with the time, and is modified by the nature of the previous pressure changes. The influence of subsidiary stoppages is investigated, and experiments are discussed showing the influence of temperature.

The opportunity is taken of considering the secular change of zero, and also changes in the elastic and the after-effect properties.

Algebraic and exponential formulæ are obtained for such phenomena as the variation of the differences of the descending and ascending readings throughout a pressure cycle, the dependence of the sum of such differences on the range, the fall of reading at the lowest pressure and the final recovery. A theory, to some extent empirical, is built up, leading to mathematical results, depending on only three arbitrary constants, for the behaviour of an aneroid in the ordinary Kew test over any range.

The large differences brought to light between different aneroids show that the means of markedly raising the average are already at the makers' disposal. The present inquiry shows clearly how the effects of tentative improvements may be ascertained.

Physical Society, June 24.—Mr. Walter Baily in the chair.—Prof. Carus-Wilson exhibited an apparatus to illustrate the action of two electric-motors coupled in such a way as to admit of their rotating at different speeds. The two shafts are placed in line, and each is fitted with a bevel-wheel, gearing into an intermediate wheel. The axis of the intermediate wheel is at right angles to the line of the motor-shafts, and is free to rotate in a plane at right angles to that line. The motors can be made to rotate at different speeds by altering the strength of the magnets of either or both. The motion of the intermediate wheel depends upon the difference of the two speeds, or upon their mean, according to their relative directions of rotation. A simple graphic construction enables the action to be predetermined for any given load on the intermediate wheel. Calling the two motors A and B, and the intermediate wheel C, lines can be drawn on a base of current to represent the speeds and the torques for each motor. If the motions of A and B are in the same direction, the load or torque is the same on each, and of similar sign. Hence, as the load on the wheel C is increased, the speeds of A and B tend to become equal (if A had been running faster than B); and for a certain load on C the speeds of A and B will be equal. If the load on C is further increased, B will run faster than A. Also, there will be a certain value for the load on C at which the motion of A will reverse. A further increase of the load on C will bring C to rest, A and B then rotating at equal speeds in opposite directions. When the load on C is nothing, let the motors rotate in opposite directions, A running faster than B. The motion of C now depends upon the difference of speeds of A and B. When a load is put on C, the motion of A is retarded, while that of B is assisted, hence B takes less current, and A takes more. The torques on the two motors, due to the load on C, are now of equal amount, but of opposite sign. As the load on C is increased, the speed of A is reduced, and that of B increased, until the two are equal, and C comes to rest. B is now acting as a generator, and sending current into A. If the load on C is simply that due to friction, the process cannot be carried further. But if the load on C is reversed, the speed of B becomes greater than that of A, and the motion of C is reversed. In the steering gear designed by the Union Electricitäts Gesellschaft, the intermediate wheel is made to actuate a rudder by differential action. The motion is reversed by making the speed of one motor greater or less than that of the other.—Mr. Quick then exhibited Weedon's apparatus for the measurement of the expansion of solids. This method is claimed to be independent of knowledge of optics on the part of the student. The expansion is read directly by means of a pair of micrometers. Precautions are taken to prevent errors due to radiation. Mr. Lehfeldt asked what precautions were taken to prevent the movement of the micrometer supports. Mr. Stansfield described a form of apparatus in use at Chelsea Polytechnic; it was a simple contrivance, in which changes of length were measured by a micrometer. Mr. Quick, replying, thought the instrument referred to by Mr. Stansfield pre-supposed a knowledge of optics.—Mr. Lehfeldt then read a paper by Dr. Donnan on the theory of the Hall effect in a binary electrolyte. In 1883 Roiti investigated the subject of a possible Hall effect in electrolytic solutions. He failed to obtain any positive result. Recently the question has been examined by Bagard, who noticed certain effects in aqueous solutions of zincic and cupric sulphates. Meanwhile, negative results have been observed by Florio. The author therefore discusses what effect might be expected by theory, on somewhat the same lines as those of Van Everdingen, jun., taking a more general case. So far as the present discussion goes, the author's theory is wholly in favour of the negative results of Roiti and Florio. It would appear that Bagard measured a phenomenon not contemplated by the theory as stated in the present treatment. Van Everdingen originally supported the positive results of Bagard; but his work, unfortunately, was rendered incorrect by the accidental omission of a numerical factor. He has since discovered the slip in his calculations, and now agrees with the author's conclusions.—The Chairman proposed votes of thanks to the authors, and the meeting adjourned until October, this being the last of the session.

Linnean Society, June 16.—Dr. A. Günther, F.R.S., President, in the chair.—Prof. J. B. Farmer and Mr. W. G. Freeman demonstrated the action of germinating peas, cress, and barley in causing the deoxidation of a watery solution of methylene blue to a colourless liquid on shaking up the latter with air, while on adding a drop of hydrogen peroxide the blue colour was restored. Green plants placed in the solution were found to act in a manner precisely similar to the seedlings, though the action may be modified by assimilation in sufficient light (see p. 185).—Mr. F. Enock exhibited and made remarks on the eggs of an hemipterous insect containing living parasites (*Prestwichia aquatica*), of whose life-history and habits

he gave a detailed account (see p. 175).—Prof. Herdman, F.R.S., exhibited some dissections, microscopic preparations, and drawings to illustrate the presence of modified pedal muscles in the oyster. It was shown that there was reason to believe that these muscles, the insertion of which into the shell had been noticed in the American oyster by Ryder and Jackson, were the representatives of the *protractor pedis* of other Pelecypoda. But, as the oyster has no foot in the adult, the muscles have been modified in their distribution and have acquired a new function.—Mr. Miller Christy read a paper entitled "Observations on the seasonal variations of elevation in a branch of a horse-chestnut tree."—A paper was read by Mr. G. W. Carpenter on *Pantopoda* collected by Mr. W. S. Bruce in Franz-Josef Land, in which he recorded the existence of eleven species, one of which he described as new. Of this, *Nymphon piliferum*, a detailed description was given, as of a new variety *Nymphon piliferum* var. *abbreviatum*.—A paper was read by Mr. J. E. Duerden on the morphological relationship of the Actiniaria and Madreporaria.—Dr. C. Forsyth-Major communicated a paper on some fossil Leporines, an abstract of which was given by Prof. Howes. The author's investigations are based on the description of Miocene fossils collected by himself in Sardinia, France and Italy, and on specimens preserved in the Museum of Natural History.

PARIS.

Academy of Sciences, June 20.—Centenary of the foundation of the Conservatoire des Arts et Métiers, by M. Laussedat.—Actinometry in experimental balloons, by M. J. Violle.—On the study of the upper atmosphere, by M. L. Cailletet. An account of an experimental balloon ascent of June 8. The balloon was fitted with self-recording instruments, the lowest reading of the barometer, 118 m.m., corresponding to a maximum height of 13,700 metres.—On the boiling point of liquid ozone, by M. L. Troost. The temperature was determined by means of an iron-constantin couple, previously standardised in ice, boiling methyl chloride, nitrous oxide, ethylene, and oxygen. Several measurements were taken, the ozone always boiling steadily at $-119°$ C.—Preparation of crystallised calcium, by M. Henri Moissan. After a historical review of previous work on the subject, two methods are described which furnish calcium in white, hexagonal crystals (see p. 209).—On the classification of the Tunicates, by M. Edmond Perrier.—New gases in atmospheric air, by MM. Ramsay and Travers. An account of the discovery of neon and metargon.—On the Rubiaceæ of the Madagascar flora, by M. Emm. Drake del Castillo.—Comet discovered at the Observatory of Nice, by M. Giacobini.—Provisional elements of the Perrine comet (June 14, 1898).—Observations of the Coddington comet, Perrine comet (June 14), and the Giacobini comet, made at the Observatory of Toulouse with the Brunner equatorial, by M. F. Rossard.—Observations of the new Perrine comet (June 14) made at the Observatory of Paris, by MM. G. Bigourdan and G. Fayet.—Observations of the Coddington comet (June 11, 1898) made with the large equatorial at the Bordeaux Observatory, by M. L. Picart.—Application of interference fringes to the study of micrometers, by M. Maurice Hamy. A half-silvered lens of very slight curvature is fixed to the body of the micrometer, and a mirror to the moving portion of the instrument, the whole is illuminated with monochromatic light, and the method of fractional excess applied to the Newton's rings thus produced.—The equivalence group and kinematic bases, by M. Jules Andrade.—On the stability of equilibrium, by M. L. Lecornu.—On an apparatus called the anemotrope, by M. Maillet.—An optical method for measuring lengths up to several decimeters, by MM. A. Perot and Ch. Fabry.—Influence of tempering upon the electrical resistance of steel, by M. H. Le Chatelier. The resistance of steel is not influenced by tempering at temperatures below 710°, the temperature of recalescence. The resistance after tempering at 850°–1000° is about double that of the untempered metal. Some chrome and tungsten steels were also studied. At high temperatures chromium exaggerates the increase of resistance produced by tempering. 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