THURSDAY, APRIL 17, 1890.

THE GROWTH OF CAPITAL.

The Growth of Capital. By Robert Giffen. (London: G. Bell and Sons, 1889.)

THE popular conception of what statistics are is happily caricatured by a contemporary novelist, who describes an adept in that science stationing himself early in the morning at the entrance to a bridge, and, after scrutinizing the passengers for several hours, triumphantly reporting that exactly 2371 widows have crossed during the day. This arithmetic of the street is not the type of Mr. Giffen's calculations. His purpose is more philosophical, his method more elaborate.

The object which he seeks to measure is nothing less than the whole property, the accumulated exchangeable wealth, of the United Kindom. In this problem, to apprehend even the question requires an effort of intelligence. "Imagination shrinks from the task of framing a catalogue or inventory of a nation's property, as a valuator would make it." Reason points out that the grand total is not so much the value of the whole, which in its entirety cannot be considered saleable, as the sum of the values of all the parts, any one of which may be sold by its proprietor. The attribute of accumulation, as well as that of exchange, requires careful definition. Mr. Giffen, differing from some of his predecessors and contemporaries, does not regard the labourer himself as a species of capital. He does not, with Petty, attempt to determine the "value of the people," nor, with De Foville, to effect "the evaluation of human capital." However, some items which are of an incorporeal nature seem to enter into his account. Presumably, that part of the national capital which he reckons by capitalizing the income of public companies—multiplying it by a certain number of years' purchase—represents the value, not only of land and plant, but also of an immaterial something, which, in a broad sense, may be described as "custom" or "good will." Mr. Giffen doubts whether public debt should be admitted as an item of capital. He is certain that tenant-right should be excluded.

The uses of such a valuation are manifold. Mr. Giffen devotes a chapter to their enumeration. In the first place, it is desirable to compare our resources with our liabilities. It is satisfactory to find that the national debt compared with the national fortune is but a "bagatelle." The amount of a country's accumulations, and the rate of their increase, afford some measure of its capacity to endure the burdens of taxation, and, we may add, other kinds of pecuniary strain. It is observed by Newmarch, one of Mr. Giffen's predecessors in this department of statistics, that the investment in railways, which produced such convulsions in 1847-48, would have been in 1863 almost unfelt and insignificant in comparison with the yearly savings which were being made at the later epoch.

One use to which Mr. Giffen gives prominence may be thus described. The comparative growth of capital at different epochs serves as a sort of barometer of national prosperity. Of course those who use a barometer must remember that its indications of fair weather are but indirect and inferential. He who trusts the rising of the mercury when the north-east wind is blowing may get a wetting. So also with the metaphorical weather-glass. "The property test is useful as far as it goes, but it is not the only test," says Mr. Giffen. Elsewhere, in his address to the British Association, he has acted the part of a Fitzroy in considering together and interpreting in their connection the various tests and signs which economic meteorology affords. His object here is rather to perfect one particular instrument.

This barometrical use of capital may involve the necessity of correcting the estimates so as to take account of changes in the value of money. It may happen, it has happened, that in the last decade, as compared with the preceding period, the growth of capital estimated in money shows a falling off, while the increase of money's worth, of things, has not declined proportionately. To complete our measurement we must correct the measuring-rod. This is no easy or straightforward task. In the case of a real barometer we can mark the inches by reference to the standard yard measure, which is kept in the Tower. But a similarly perfect measure of value is, in the phrase of an eminent living economist, "unthinkable." The present generation finds itself, with respect to the variations in the value of money, in the sort of difficulty which must have occurred to the primæval man when first he may have noticed that a perfect measure of time was not afforded by the length of day and night, and before there had been constructed a more scientific chronometer. Even Mr. Giffen has to content himself with such rough and rather arbitrary corrections as the present state of monetary science affords.

As the object sought, the measure of accumulation, is somewhat hazy and difficult to envisage, so the method by which it is approached is indirect and slippery. The business man must not suppose that the estimates of a nation's capital can be totted up with the precision of a commercial account. The physicist is better prepared to appreciate the character of the computation, conversant as he is with observations which individually are liable to a certain error, while, put together, they afford certainty. But even physical observations, liable to a considerable yet calculable extent of error, hardly parallel the fallibility of these economic or, if we might coin a required word, *metastatistical* computations. In estimating that fallibility, we may usefully employ the analogy suggested by the theory of errors; but we must bear in mind the criticism to which this theory, even in its application to physics, was subjected by a witty mathematician: "After having calculated the probable error, it is necessary to calculate the probability that your calculation is erroneous."

The characteristic to which we draw attention is fully recognized by Mr. Giffen. Again and again he dwells on the rough and approximative character of his method, "the wide margin of error," and the "limit of information available." His cautions against reasoning too finely might have seemed superflous in their iteration, but that he doubtless anticipated the irrelevant criticism which each departmental statistician might direct against details —like the specialist in sculpture who, according to Horace, represents with peculiar accuracy the hair or nails, but *nescit componere totum*.

The futility of a penny-wise precision, and even of that criticism which sticks at a few thousand pounds where millions or tens of millions are the units of the scale, will be apparent when we consider the construction of the colossal account. The starting-point of the computation is afforded by the income-tax returns. The income under each head thus evidenced is multiplied by a certain number of years' purchase to form the corresponding item of capital. Thus, in the valuation of 1885 there is, under the head of "Houses," the income £128,459,000, which, being multiplied by 15, the number of years' purchase, gives £1,926,885,000 as the corresponding entry of capital. Again, under "Farmers' Profits," the income is £65,233,000, which, being capitalized at 8 years' purchase, makes £521,864,000 capital. Now, of course, neither are the income-tax returns perfectly accurate, nor can the number of years' purchase proper to each category be assigned with precision. A further element of uncertainty is introduced when, in the case of "Trades and Professions," we reduce the income-tax return by a somewhat arbitrary factor, one-fifth, in order to take account only of that income which results from accumulated property as distinguished from personal exertion. Where the income-tax is no longer available for our guidance, the procedure becomes even more precarious. Thus "Movable Property not yielding Income," such as furniture of houses and works of art, is estimated as amounting to half the value of "Houses," that is, £960,000,000. Even the most faithful follower of Mr. Giffen may be staggered when with reference to such entries he reads—

"The estimates of the income of non-income-tax paying classes derived from capital of movable property not yielding income, and of Government and local property, are put in almost *pro formâ* and to round off the estimates, and not with any idea that any very exact figures can be stated."

But whoever carefully considers the principles on which Mr. Giffen has assumed the different coefficients entering into his computation—principles set forth more fully in a former essay—will be satisfied that he has in no case run a risk of overrating. We may therefore accept his estimate of the national capital in 1885 as a figure round indeed, but not exaggerated. That figure is £10,000,000,000.

Greater precision may be attainable where there is required, not the absolute amount of capital in 1885, but the ratio of that amount to the corresponding estimate for 1875, in order to compare the growth of the national resources during that decade with the growth at a previous period. We shall now be assisted by the important principle which Mr. Giffen thus notices :—

"According to well-known statistical experience, the comparison of the growth or increment may be reasonably successful, if the same method is followed on each occasion in working out the data for the comparison, although these data themselves may be unavoidably incomplete."

Let us put our *quæsitum* in the form of a fraction, thus :—

$$\frac{\text{Lands in 1885} + \text{Houses in 1885} + \&c.}{\text{Lands in 1875} + \text{Houses in 1875} + \&c.}$$

(using lands, &c., as short for value of lands, &c.). It is evident that any source of inaccuracy which exaggerates or diminishes both the numerator and denominator in the same proportion is not operative on the result. If all the data were based on income-tax returns, and the same proportion of property escaped the net of the collectors at each epoch, the result would be undisturbed.

But all the data are not based on the income-tax ; nor, even if there were no increased stringency in the collection of the tax as a whole, or any other general derangement, could it be supposed that the defalcations under each head observed an exactly uniform proportion. To estimate the effects of this unequal distortion, it will be convenient to alter our statement by putting in the numerator, instead of lands in 1885, the expression—

$$\text{Lands in 1875} \times \frac{\text{Lands in 1885}}{\text{Lands in 1875}},$$

with corresponding changes for the other entries. Thus the *quæsitum* may be considered as a sort of mean—a weighted mean—of the ratios between the several items for the two years. In this expression the influence which the two elements, the absolute quantities used as *weights* and the ratios, exercise upon the error of the result is different. The influence of error in the absolute quantities would be comparatively small, if those quantities were tolerably equal and the ratios not more unequal than they are. But, unfortunately, the absolute quantities are extremely unequal. Out of the twenty-six items, "Lands" and "Houses" together make up more than a third of the sum-total. By a formula adapted to the case, it may be calculated that, if each of the twenty-six quantities be liable to an assigned error per cent. (exclusive of such mistakes as, affecting the numerator and denominator of the result in an equal proportion, disappear in the division), then the percentage of error incident to the total result is not likely to be less than $\frac{3}{8}$ths of the error affecting each of the parts. That is, abstracting the inaccuracy of the ratios, which are of the form—

$$\text{Lands in 1885} \div \text{Lands in 1875}.$$

Now any error in the ratios is more directly operative on the result than the same degree of error in the absolute quantities. But, on the other hand, it may be that the error actually affecting the ratios is particularly small, owing to the favourable operation of that general principle which we have just now cited from Mr. Giffen's pages. The estimate of inaccuracy must, however, be increased to some extent by the error of the ratios. Altogether it would seem that the whole chain or coil is not so much stronger than the particular links or strands as is usual in the calculation of probabilities. It would be a moderate estimate that the percentage error of the compound ratio is not less than a half of the error on an average affecting each of the components—lands, houses, &c.—in either year.

What degree of error, then, shall we attribute to each of these items? A precise determination of this coefficient is, as we have already observed, impossible. It would be interesting to collect the estimates of competent authorities. As a mere conjecture, for the sake of illustration, let us entertain the supposition that the error (the effective error in the sense above explained) of any one item is as likely as not to be as much as 5 per cent., and may just possibly be 20 per cent. Then we should ascribe half this degree of inaccuracy to the figure 1·175, which, according to Mr. Giffen's computation, is the ratio of the total capital in 1885 to the total capital in 1875. It would be conceivable that the real increase, as measured by some superior being, is not 17½ per cent., but as little as 7, or as much as 27, per cent. Perhaps the defect is a little more likely than the excess, if there exist any constant cause making for depression such as the increased stringency of the tax-collectors in later years.

The growth of 17 per cent. in the decade under consideration may appear surprisingly small compared with the 40 per cent. recorded for the preceding decade. The general accuracy of the contrast is, however, confirmed by a comparison of the growths in each item for the two decades. Mr. Giffen points out that in the former decade, unlike the latter, there are no growths downwards. Also the percentages which measure increase run mostly at a higher level for the earlier period. His detailed examination of the figures leaves nothing to desire. For a summary contrast between the two sets of percentages we might submit that a proper course would be to compare the *medians* of the respective sets of figures (the arithmetic means would not be suitable owing to the very unequal importance of the figures relating to such miscellaneous items). Operating in the manner suggested, we find as the median of the first set of percentage growths 50, and of the second 25, thus confirming Mr. Giffen's conclusion that the former movement is about double the latter.

The conclusion that in the last decade our progress has been only half what it was in the preceding decade is at first sight disappointing. But we must remember that as yet we have accomplished only part of our calculation. We have still to make a correction for the change in the value of money which may have occurred between the two periods. This is a problem familiar to Mr. Giffen. In his classical computations of the changes in the volume of our foreign trade he encountered and surmounted a similar difficulty. In that case he ascertained the change in the level of prices at which exports and imports ranged in different years without going beyond the statistics of foreign trade, and by operating solely on the prices and quantities of exports and imports. It might be expected, perhaps, that he would pursue an analogous course in constructing a measure for the change of prices affecting the volume of capital. He would thus have been led to adopt the very ingenious method of measuring changes in the value of money which has been proposed by Prof. J. S. Nicholson. But, however cognate that original idea may be to the theory of the subject, it will be found in practice not easy to apply to the present computation. At any rate, Mr. Giffen has taken his coefficients for the correction in question, not, as before, from the subject itself, but *ab extra*, from Mr. Sauerbeck, Mr. Soetbeer, and the *Economist*. Averaging their results, he finds that money has appreciated to the extent of 17 per cent. during the interval under consideration. This correction being made, the growth of capital in the period 1875–85 proves to be about the same as the growth in 1865–75.

The soundness of this conclusion is confirmed by some reflections which at first sight might appear open to criticism. After using the fall of prices to prove the increase of capital, Mr. Giffen turns round and seems to reason from the increase of capital to the fall of prices.

"If two periods are compared in which the increase of population is known to be at much the same rate throughout, and the increase of productive capacity may be assumed to be at the same rate, or not less, in one of the periods than in the other, then, if the apparent accumulation of capital in the one period proved to be less than in the other, it must be ascribed to some change in the money values."

This reasoning may appear circular to the formal logician. But, in the logic of induction, we submit that it is very proper for two arguments archwise to support each other. The consilience of different lines of proof is indeed an essential feature of the logic of fact, as formulated by J. S. Mill. We venture to interpret Mr. Giffen's double line of proof by the following parable. Has it never occurred to you, reader, on looking at your watch, and finding the hour earlier than you expected, to suspect that the instrument has played you false? You review what you have been doing; recollect, perhaps, that you began work or got up earlier than usual; and, on reflection, see no reason to distrust your watch. You test the watch by the time, and you measure the time by the watch. Similarly, Mr. Giffen is quite consistent when he measures the extent of the growth of capital by the extent of the fall in prices; and confirms the fact of a fall in prices by the independently inferred fact of a considerable growth of capital.

In connection with the fall of prices we should notice an important contribution which Mr. Giffen makes to monetary science by defining the ambiguous term "appreciation." The readers of NATURE who may be more familiar with physical than social science will smile when they understand that there has been in economical circles a stiff controversy on the following question: Whether, if there is not now in circulation a sufficient amount of money—in proportion to the quantity of commodities circulated—to keep up prices to a former level, the cause of the fall is the scarcity of gold or the abundance of goods. It is as if, when the shoe pinched, people should dispute whether the shoe is too small, or the boot too large. The mirth of the physicist seems for the most part justified. However, as Coleridge or somebody said, before we can be certain that a controversy is altogether about words, there is needed a considerable knowledge of things. The better class of controversialists in the matter before us have doubtless had a meaning, but a latent and undeveloped one, which it required our author, like another Socrates, to bring to birth. The issue appears unmeaning, as long as you consider the question in Mr. Giffen's phrase "statically," without reference to the rate at which the quantity of goods and gold are growing. But "dynamically," if goods and gold cease to move abreast, it is intelligible to attribute the separation between the two to the operation of one rather than the other. As we understand the matter, using our own illustration, let us liken the constant growth of goods to the uniform velocity of a boat carried onward by a steady stream; and the parallel increase of money to the movement of a pedestrian on the bank. If the pedestrian, after keeping abreast with the boat for some time, is at length found to be behind it, it is reasonable to attribute the change to the man, and not the stream. But all turns upon the assumed steadiness of the stream's onward movement. Looking back on past experience, Mr. Giffen entertains the hypothesis of a constant or "normal" growth of property. But with respect to recent years, it would be possible to cite, from other high authorities, expressions of a contrary opinion. But, if the steady motion of goods is not accepted, presumably the issue between "scarcity of gold" and the opposed theory of appreciation will turn upon a comparison of the rates at which the rate of increase varies for money and commodies respectively—an investigation of *second differentials* which we could not regard as serious.

The difficulties of monetary theory do not attend some of the uses to which the estimate of national capital may be applied. It is not necessary to make a correction for the variation of money when we compare our own with a foreign country in respect of absolute quantity, and even growth, of accumulation. Our colossal capital compares not unfavourably with the capital of the United States, perhaps equal in amount, but much less per head. The £10,000,000,000 of the United Kingdom compares favourably with the £7,200,000,000 of France weighted by a heavy debt, and the surprisingly small £1,920,000,000 of Italy.

The comparison of provinces, as well as nations, is also instructive. Mr. Giffen finds that Ireland has less than a twentieth of the property belonging to the United Kingdom. The property per head in Ireland is less than a third of what it is in England, and not much more than a third of what it is for Scotland. Upon these facts Mr. Giffen remarks:—

"Reckoning by wealth, England should have 86 per cent. of the representation of the United Kingdom, or 576 members out of 670; Scotland, by the same rule, should have about 64 only; and Ireland no more than 30. . . . There should be a representation of forces in Parliament, if we had perfectly just arrangements, and not merely a counting of heads. Nothing can be more absurd to the mind of any student of politics, who knows how forces rule in the long run, than the system now established, as between the metropolitan community of England and its companions in sovereignty, by which one of the companion communities, and that the least entitled to privilege, obtains most disproportionate power."

One of the most legitimate uses to which estimates of national capital can be put, is to ascertain the progress of wealth from age to age. In an historical retrospect, Mr. Giffen reviews the work of his predecessors, rescuing from an undeserved neglect more than one writer who had the courage and sagacity to employ what Colquhoun calls "approximating facts." The succession of estimates, from the age of Petty to the present time, appears to justify the hypothesis of a constant increase of property—a five-fold multiplication per century. Contemplating the long series of records, Englishmen may reflect with pride that the increased estimates are matched by an ncreasing power of handling them, that the growth of material prosperity has not been attended by a decline in statistical genius, and that the work of Petty is continued by one who is worthy to be compared with the founder of Political Arithmetic. F. Y. E.

MERGUI.

Contributions to the Fauna of Mergui and its Archipelago. 2 Vols. (London: Taylor and Francis, 1889.)

THE materials which have been brought together in these volumes are now made accessible to those specially interested in the fauna of this group of islands in a connected form. The collections were made in 1881-82 by Dr. John Anderson, F.R.S., till recently Director of the Indian Museum at Calcutta, who brought the specimens to England with him, and placed the different groups in the hands of specialists for their proper identification and description. The result has been the publication of a number of faunistic papers in the Journal of the Linnean Society and elsewhere, and these papers are now published in the form of two volumes, well illustrated with plates, and containing altogether nearly two dozen distinct memoirs by recognized authorities in the different departments.

In the first volume Prof. P. Martin Duncan writes on the Madrepores, and in his concluding remarks calls attention to the remarkable distinctness of the existing as compared with the Miocene corals of the same area. Prof. F. Jeffrey Bell's paper on the Holuthuria comes next in order, and is followed by Mr. F. Moore's paper on the Lepidoptera, the collection in the last order containing 208 species of butterflies, and 64 species of moths. The Sponges are described by Mr. H. J. Carter, F.R.S., and the Ophiuridæ by Prof. Martin Duncan, who contributes also a special paper on the anatomy of *Ophiothrix variabilis* and *Ophiocampsis pellicula*. The Polyzoa and Hydroida are taken in hand by the Rev. Thomas Hincks. The Coleoptera have come off badly, if Mr. Bate's description of one new species (*Brachyonychus andersoni*) represents the whole of the material collected in this order. We suspect, however, that more will be heard about the Mergui beetles at some future period.

Dr. Anderson himself contributes the list of birds, which he regards "merely as a small supplementary contribution" to Messrs. Hume and Davison's labours in the same field. The list chiefly records the distribution in the outer islands of the archipelago of a few of the species recorded by these last authors. Dr. Hoek, of Leyden, writes on a Cirriped (*Dichelaspis pellucida*), which does not appear to have been observed since Darwin published his original description in his monograph. The shells—marine, estuarine, freshwater, and terrestrial—form the subject of a paper by Prof. E. v. Martens, of Berlin. Mr. Stuart Ridley has been entrusted with the Alcyonaria, and Prof. A. C. Haddon describes two species of Actiniæ. The Annelids are treated of by Mr. Frank E. Beddard, who includes in his paper an important section on the structure of the eyes in one of the species described. The Pennatulida are treated of by Prof. Milnes Marshall and Dr. G. H. Fowler, and the Myriopoda by Mr. R. I. Pocock, this being the first list of species recorded from the archipelago. The Comatulæ are described by Dr. P. Herbert Carpenter, the Echinoidea by Prof. P. Martin Duncan and Mr. W. P. Sladen, and the Asteroidea by this last author. These organisms, when referable to known species, "show variations which are sufficient to impart a character to the collection as a whole, and to indicate the existence of local conditions whose action upon types of a more plastic nature than that of the series of forms so far collected would probably result in new morphological developments." Mr. Sladen further throws out the suggestion that the Mergui area "may be looked upon as a moulding ground wherein Malayan types assume a modified form." A description of the physical conditions prevailing in the localities where the Asteroidea were collected is contributed by Dr. Anderson, and adds much to the value of this paper. The paper on the Mammals, Reptiles, and Batrachians is by Dr. Anderson, the three classes being represented by 23, 53, and 12 species respectively. The whole of the second volume, containing over 300 pages and 19 plates, is devoted to the Crustacea, the author entrusted with this order being Dr. J. G. de Man, of Middleburg, Netherlands. It should be added that this part of the work relates only to the stalk-eyed Crustacea.

The names of the different specialists who stand responsible for their respective contributions are sufficient guarantee that Dr. Anderson and the Calcutta Museum have been the means, aided largely by the Linnean Society, of giving to the public a substantial and trustworthy contribution to the natural history of a much-neglected group of islands. The proximity of the archipelago to the main land of course precludes the possibility of expecting much in the way of insular forms. There is one paper, however, contributed by Dr. Anderson, and forming the second part of the first volume, which will be read with interest by anthropologists, as it contains a description of a peculiar race of sea gipsies called "Selungs," who frequent the archipelago and inhabit many of its islands. These people appear to be sufficiently distinct from those of the main land to warrant their being regarded as an insular race, probably having Malayan affinities. At any rate, all that we know about them at the present time is contained in the paper referred to, which is accompanied by two photographic groups of the people, a photograph of their boats, and a lithographed plate of their weapons and utensils. There is also a vocabulary of their language, which, according to General Browne, bears not the slightest affinity to Burmese, but which Dr. Rost reports to be distinctly Malayan.

R. M.

HOW TO KNOW GRASSES BY THEIR LEAVES.

How to know Grasses by their Leaves. By A. N. M'Alpine. (Edinburgh: David Douglas, 1890.)

THIS little book will be a valuable aid to agriculturists and agricultural students. It is small, and adapted for carrying in a side pocket. It comes out seasonably, as the time is fast approaching in which its teaching may be verified in the field. It fills a gap in our knowledge of grasses, as botanists usually decide species by the inflorescence, rather than by the leaves. Colour, habit of growth, and form of leaf, are, we know, somewhat variable characters, and cannot always be relied upon; and in questions relating to the absolute identification of species, no doubt, inflorescence is of first importance. There is, however, a practical knowledge which derives immense benefit from the kind of information contained in Mr. M'Alpine's work, and after having determined approximately the component parts of a pasture in the young state, it is open to the observer to wait for further proof in the spike or panicle, which will in due time appear. A grass-field contains a larger number of species, not only of grasses but of clovers, other leguminous plants, and miscellaneous herbage, belonging to the *Compositæ*, *Umbelliferæ*, *Rosaceæ*, and other natural orders. This book treats solely of the grasses, and clearly, and with the help of 200 figures, shows how any person may identify grasses in the leafy stage. "The difficulties connected with the identification of grasses in the flowerless condition," says Mr. M'Alpine, "are not at all so great as usually supposed." This is good news from the botanist of the Highland and Agricultural Society of Scotland, Professor of Botany in the New Veterinary College, Edinburgh, and translator of Stebler's "Best Forage Plants." The great and varied knowledge of Mr. M'Alpine, is in itself a guarantee that the distinctions he has traced between the blades and stems of grasses are not of a hasty or flimsy character. Many of them are new to us, but others we have noticed ourselves, and know them to be correct. Any one furnished with a copy of this little book, and a small magnifier, will find that an additional interest will be communicated to walks in the fields, and the question as to the nature of the growing herbage of pastures may be satisfactorily answered. An eye trained to observation will be able to detect slight differences better than the eye which sees not, but we feel confidence that a careful examination of the plates and the letterpress of this little book will, if used in the field, be in itself a training in habits of observation. The book should be in the hands of every agricultural student, as it in due time will become the basis of questions at examinations. The facts that Mr. M'Alpine is himself a teacher, and that Prof. Wallace, of Edinburgh University, has written the preface, point to this conclusion.

The price for so small a book (3*s.* 6*d.*) certainly appears very heavy; but if it is called for in sufficient numbers, we shall doubtless soon hear of a cheaper edition. The demand for books of this class is small, as most farmers do not read more than is good for them, and the subject is not of great interest to the general reading public.

The classification adopted by Mr. M'Alpine is not that of genera and species. For example, rye-grasses (*Lolium*) and meadow fescue (*Festuca*) are grouped together, as having red bases to their stems; crested dog's-tail grass is peculiar for a yellow stem base; meadow fox-tail, for a dark or almost black stem base; Yorkshire fog, for having a white sheath, with red veins. These colours at the base of the stem, taken together with other characters, are used to identify the species, and the grasses which are known by the colours just enumerated form a group described as "characteristically coloured grasses." Group II. includes variegated grasses, whose leaf-blades are composed of alternate strips of white and green tissue. Group III. includes bulbous grasses, with low, flat ribs, such as Timothy grass and false oat grass. Group IV., cord-rooted grasses in hill pastures, such as mat grass and purple Molinia. Group V., acute sheathed grasses, so named on account of their sharp edges. The shoots are quite flat on the sides and the edges acute—such are cocksfoot and rough-stalked meadow grass. Group VII., bitter tasted grasses. Group VIII., bristlebladed grasses. Group X., hairy grasses. Group XII., ribless bladed grasses. Groups VI., IX., and XI. are separately dealt with, but those above-mentioned will sufficiently show the principle upon which the classification is made.

The figures (diagrams), showing the tapering, obtuse, flat, involute, or imbricate character of the herbage, are exceedingly plain and characteristic, and will be of great assistance to the observer in the field. The leaf-blades, stems, ligules, sheaths, &c., are well shown in cross-sections, and at length. JOHN WRIGHTSON.

OUR BOOK SHELF.

Facsimile Atlas to the Early History of Cartography, with Reproductions of the most important Maps printed in the Fifteenth and Sixteenth Centuries. By A. E. Nordenskiöld. Translated from the Swedish original by J. A. Ekelöf and Clements R. Markham. (Stockholm, 1889.)

IN this handsome volume there are 142 pages of letter-press in imperial folio, and 51 plates in double folio. It contains reproductions of about 160 of the rarest and most important maps printed before the year 1600. Among these are the 27 maps of Ptolemy, edited by Schweinheim-Buckinck in Rome, 1478 and 1490; maps from Berlinghieri's "Geographia," Firenze, c. 1478; Aeschler's and Übelin's "Ptolemy" of 1513: Reisch Margarita Philosophica, of 1503 and 1515; Lafreri's "Atlas," Romæ, c. 1570; Richard Hakluyt's "Petrus Martyr," Paris, 1587, and "Principal Navigations," London, 1599; maps of the world, by Ruysch, 1508, Bernardus Sylvanus, 1511, Hobmicza, 1512, Apianus, 1520, Laurentius Frisius, 1522, Robert Torne, 1527, Orontius Finacus, 1531, Grynæus, 1532, Mercator, 1538, Girava, 1556, de Judæis, 1593. We find also the first modern printed maps of the northern regions, of the Holy Land, of Central Europe (by Nicolas a Cusa), of France, of Spain, of England, of Russia; the first charts for the use of mariners published in print; 82 general maps, or maps referring to the New World; the first modern printed maps of Africa; the first map illustrating the distribution of religious creeds, &c.

As regards the text, chapters i.–iii. contain researches relating to the influence of Ptolemy on modern cartography, his merits and defects, and the different editions of his geography. Of the editions enumerated in bibliographical works, 27 spurious ones are neglected. In chapter iv. a review is given of ancient maps other than Ptolemaic, of the portolanos and their influence on modern geography. Chapter v. treats of the extension of Ptolemy's *Oikumene* towards the north and north-west, the pre-Columbian maps of Scandinavia and Greenland, the most remarkable of which is one discovered by Nordenskiöld himself in a library at Warsaw (reproduced on Tab. xxx.) Chapter vi. deals with the first maps of the New World, and the then recently discovered parts of Africa and Asia. Here the author draws attention to the hitherto neglected fact that maps from Vasco de Gama's second voyage were printed as early as 1513 (reproduced in the letterpress, Figs. 8–10). Chapter vii. gives an account of early terrestrial globes, and in chapter viii.—on map projection—the author corrects several errors generally adopted in the history of this part of cartography. In chapter ix. he deals with the end of the early period of cartography, and in chapter x. with the transition to, and the beginning of, the modern period. He brings out the importance of the work of Jacopo Gastaldi, Philip Apianus, Abraham Ortelius, and Gerhard Mercator, in the development of cartography. He also gives, besides a catalogue of the maps in Lafreri's "Atlas," a critical review of Ortelius's celebrated "Catalogus Auctorum tabularum geographicarum."

The work is based on Baron Nordenskiöld's private collection of ancient printed maps. This collection he began to make many years ago, and it is now rich in documents from the periods reviewed in the present "Atlas."

The maps have been excellently copied and printed, and the great care taken by the librarian, Mr. W. E. Dahlgren, has secured the correctness of the citations. All geographers who have a right to an opinion on the subject will agree that the work is indispensable to every library in which there is a department devoted to geography.

Light and Heat. By the Rev. F. W. Aveling, M.A., B.Sc. Second Edition. (London: Relfe Bros., 1890.)

THIS is a new edition of a text-book intended to prepare candidates for one of the science subjects of the London matriculation. It has been much improved since its first appearance, but it still treats the subject in a very superficial way. Although no one could seriously study the subject with this as a guide, it is certainly a useful summary of the main facts, and will probably be found serviceable by intending candidates. The coloured plate of spectra has been corrected, but surely this is superflous in a book which does not even describe an ordinary student's spectroscope. The author has fallen into the very common error of stating that the electric arc gives a continuous spectrum, and he also states that the lines in the spectra of the fixed stars are different from those which characterize sunlight; whereas in a great many cases they are practically identical.

There are numerous diagrams, but they are barely of a quality equal to those which would be produced by a student at an examination. The large collection of questions and answers will be very useful.

Warren's Table and Formula Book. By the Rev. Isaac Warren. (London: Longmans, Green, and Co., 1889.)

WE have in this small work a compact and trustworthy set of tables, facts, and formulæ which come within the scope of an ordinary education. As a reference book, it should prove most useful, the information it conveys being concise and to the point. In addition to the usual tables of weights and measures, &c., we have an account of the physical and electrical units now in use, followed by the most important formulæ used in algebra, mensuration and trigonometry, and tables of exchange, principal units of value throughout the world, and comparative average values of some important coins, the last of which will doubtless be found useful to those travelling abroad. Some of the most important business forms, such as "Form of a Joint Promissory Note," "Form of Foreign Bill of Exchange," &c., are printed in full; and the work concludes with postal and telegraph rates. On the back of the cover are printed diagrams of a square decimetre and centimetre and a square inch, together with scales of centimetres and inches.

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.*]

"Panmixia."

THE somewhat strained argumentation which Mr. Romanes has devoted in your issue of April 3 (p. 511) to my defence of Mr. Darwin's position in regard to "cessation of selection" and "economy of growth" does not convince me of the justice of the former's claim to have originated new principles "unfortunately" (to use his own expression) too late for Mr. Darwin to have the advantage of correcting himself by their aid. In his letter of March 13 (p. 437) Mr. Romanes lays great stress in criticizing Weismann upon what he calls "reversal of selection," which he now tells us is the same principle as "economy of growth." Yet in the earlier letter he entirely omits to credit Mr. Darwin with the recognition of that principle, and after carefully asserting that Mr. Darwin had overlooked the principle of "panmixia," he gives in an historical form what *he* (Mr. Romanes) had argued some years ago, and what *his* views were—including herein the principle of economy of growth, or more generally, reversed selection. Now that the oversight has been pointed out to him Mr. Romanes allows that "it is a matter of familiar knowledge that Mr. Darwin at all times, and through all his works, laid considerable stress upon the economy of growth (or more generally, reversed selection)."

Mr. Romanes makes an unreal separation between "cessation of selection" and "reversal of selection"; at the same time, for the mere purpose of *badinage*, he affects to suppose that I do not perceive any difference between them—a supposition which cannot be sincere in view of the statements in my letter of March 27. Cessation of selection is not a "principle" at all. It is a condition which alone cannot produce any important result. At the same time, what Mr. Romanes misleadingly calls "reversal of selection," viz. "economy of growth," cannot become operative in causing the dwindling of an organ until the condition of "cessation of selection" exists. The fact is—as Mr. Romanes insisted before it was pointed out in these pages that it was no new principle of his own discovery, and when he wished to lay claim to an improvement upon Weismann's exposition of "panmixia"—cessation of selection must be supplemented by economy of growth in order to produce the results attributed to "panmixia." And inasmuch as economy of growth as a cause of degeneration involves the condition of cessation of selection, Mr. Darwin, in recognizing the one recognized the other.

By the use of the term "the principle of the cessation of selection" Mr. Romanes has created an unnecessary obscurity. To say that a part has become "useless," or "has ceased to be useful to its possessor" as Mr. Darwin does, is clearly the same thing as to say that it "has ceased to be selected"—selection and use being inseparable. Mr. Darwin states that such parts "may well be variable, for their variations can no longer be checked by natural selection." That is panmixia. It is true that Mr. Darwin did not recognize that such unrestricted variation must lead to a diminution in size of the varying part without the operation of the principle of "economy of growth." This was no strange oversight: he would have been in error had he done so. On the other hand, he did recognize that, given the operation of that principle, the result would amount to the dwindling and degeneration of parts which are referred to as rudimentary.

"Panmixia" as a term clearly refers to the unrestricted interbreeding of all varieties which may arise, when selection in regard to a given part or organ is no longer operative. The term, like its correlative "cessation of selection," does not indicate a principle but a natural condition: it does not involve the inference that a dwindling in the *size* of the organ must result from the inter-breeding; but simply points to a precedent condition.

I am by no means prepared to admit that panmixia alone (*i.e.* without economy of growth or other such factors) can be relied upon, as it is by Mr. Romanes, to explain the reduction in size of the disused organs of domesticated animals. I observe that in his letter on this subject to NATURE of April 9, 1874, Mr. Romanes does not attempt to attribute a dwindling action to "panmixia" alone, but assumes a limitation by economy of growth to any increase beyond the initial size of the organ which has become useless. Given this limitation and the condition of panmixia, the dwindling follows; but it is absurd to attribute the result, or any proportion of it, to the panmixia or cessation of selection alone. On the other hand, when we consider shape and structure, and not merely size, it is clear that panmixia without economy of growth would lead to a complete loss of that complex adjustment of parts which many organs exhibit, and consequently to degeneration without loss of bulk. That the principle of economy of growth is ever totally inoperative has not been demonstrated. E. RAY LANKESTER.

April 9.

Heredity, and the Effects of Use and Disuse.

ALL biologists will, I am sure, agree as to the desirability of a thorough testing of the hypotheses relative to the inheritance of the effects of use and disuse. As Mr. Spencer says, in the preface to "The Factors of Organic Evolution":—"considering the width and depth of the effects which acceptance of one or other of these hypotheses must have on our views of Life, Mind, Morals, and Politics, the question—Which of them is true? demands, beyond all other questions whatever, the attention of scientific men."

As experiments suggested by those who believe in the inheritance of the effects of use and disuse would hardly carry the weight to those who do not believe in this inheritance which experiments proposed by themselves would, I write to suggest the desirability of undertaking an investigation which, Prof. Weismann thinks, would prove one or other hypothesis. He states it in the following words on p. 91 of the English edition of his "Essays":—

"If it is desired to prove that use and disuse produce hereditary effects without the assistance of natural selection, it will be necessary to domesticate wild animals (for example the wild duck) and preserve all their descendants, thus excluding the operation of natural selection. If then all individuals of the second, third, fourth, and later generations of these tame ducks possess identical variations, which increase from generation to generation, and if the nature of these changes proves that they must have been due to the effects of use and disuse, then perhaps the transmission of such effects may be admitted; but it must always be remembered that domestication itself influences the organism,—not only directly, but also indirectly, by the increase of variability as a result of the suspension of natural selection. Such experiments have not yet been carried out in sufficient detail."

If Profs. Weismann, Romanes, and Lankester, would agree to some such experiment as the above as definitely proving the point in question (I say "definitely," for the sentence which reads "if the nature of these changes proves that they must have been due to the effects of use and disuse," seems rather to beg the whole question, even if the experiment were carefully carried out), there are two ways in which it might be effected. One is, that the British Association, which by devoting time to the discussion of the hypothesis has shown an appreciation of its worth, should at its next meeting appoint a committee, with a small grant for necessary expenses, to carry out the investigation. The other is, that it should be undertaken independently by the foremost of those on both sides who are interested in this question, and who would no doubt subscribe among themselves enough for the purpose in view—at least, speaking for myself, I should not object to contribute to the expenses of a properly planned investigation.

Regarding the place where the "wild ducks," or possibly some animal with a more frequent recurrence of broods, should be located for observation, I would suggest that the Zoological Society should be asked to afford space in their Gardens at Regent's Park. F. HOWARD COLLINS.

Churchfield, Edgbaston.

Galls.

THE difficulty raised by Mr. Wetterhan (NATURE, February 27, p. 394) appears at first sight a serious one, but I think it vanishes on examination. Supposing the attacks of the insects to be constant, trees in their evolution would have to adapt themselves to these circumstances, just as they have adapted themselves to the environment of soil, air, light, wind, and so forth. But the fallacy (as it seems to me) of Mr. Wetterhan's argument lies in the supposition that the life of an oak-tree as such, and the life of an insect, may rightly be compared. A tree is really a sort of socialistic community of plants, which continually die and are supplanted by fresh. Bud-variation is a well-known thing, and in oaks A. de Candolle found many variations on the same tree. Now is it unreasonable to suppose that internal-feeding insects might take advantage of such variation—or rather, be obliged to take advantage of it, if it were in a direction to benefit the tree? I will give two purely hypothetical instances, to illustrate the points involved. Imagine two oak-trees, each with three branches, and each attacked by three internal-feeding insec[illegible] The insects infesting one tree are borers; those on the other tree are gall-makers. The borers bore into the branches, which they kill while undergoing their transformations: the tree possibly does not die that year, but next year the progeny of the three, being more numerous while the tree is weaker, effect its destruction, and finally the insects perish for want of food. On the other tree, the gall-makers do no appreciable damage, and the tree is able to support them and their progeny without great difficulty. Now a little consideration will show that the longer the life and the slower the reproduction of the trees, the greater will be the contrast. If the plant infested by the borers had been an annual herb, it might have contrived to perfect its seeds, and the death of the old stem would be but a natural and inevitable process, and fresh plants might have been produced in sufficient numbers to continue the species in spite of all insect-attacks. But in the case of trees—oak-trees especially, the rate of growth and reproduction is such that, unless the insect-borers can live in galls, they will destroy the plants entirely, and themselves in consequence. Indeed, I have no doubt, that if all the gall-makers now existing could suddenly be transformed into stem-borers, the genera *Quercus*, *Rosa*, and *Salix*, now so dominant, would shortly disappear from off the face of the earth. The other hypothesis—here assuming that the production of galls is due more to the tree than the insect—is this. Suppose an oak-tree with four branches, all attacked by internal-feeding insects. Two of the branches produce swellings in which the insects live, while the other two produce none, and the insects have to devour the vital parts. Now the two branches which produced no swellings would quickly be killed by the insects, but those which produced galls would live, and the more perfect the galls, the greater the insect-population they would be able to support. Hence the tree would finally, by the survival of its gall-producing branches, become purely gall-producing, and we may assume that its progeny would inherit the peculiarity.

I am aware that the above arguments will sound a little like those of the Irishman, who said he ought not to be hanged, because, "in the first place, he did not kill the man; in the second place, he killed him by accident; and thirdly, he killed him in self-defence,"—but I do not represent either of the above hypotheses as the precise truth of the matter, and I think they sufficiently illustrate the principles involved.

T. D. A. COCKERELL.

West Cliff, Custer Co., Colorado, March 16.

On the Use of the Edison Phonograph in the Preservation of the Languages of the American Indians.

THE present state of perfection of the Edison phonograph led me to attempt some experiments with it on our New England Indians, as a means of preserving languages which are rapidly becoming extinct. I accordingly made a visit to Calais, Maine, and was able, through the kindness of Mrs. W. Wallace Brown, to take upon the phonograph a collection of records illustrating the language, folk-lore, songs, and counting-out rhymes of the Passamaquoddy Indians. My experiments met with complete success, and I was able not only to take the records, but also to take them so well that the Indians themselves recognized the voices of other members of the tribe who had spoken the day before.

One of the most interesting records which was made was the song of the snake dance, sung by Noel Josephs, who is recognized by the Passamaquoddies as the best acquainted of all with this song "of old time." He is always the leader in the dance, and sang it in the same way as at its last celebration.

I also took upon the same wax cylinder on which the impressions are made his account of the dance, including the invitation which precedes the ceremony.

In addition to the song of the snake dance I obtained on the phonograph an interesting "trade song," and a "Mohawk war song" which is very old. Several other songs were recorded. Many very interesting old folk-tales were also taken. In some of these there occur ancient songs with archaic words, imitation of the voices of animals, old and young. An ordinary conversation between two Indians, and a counting-out rhyme, are among the records made.

I found the schedules of the United States Bureau of Ethnology of great value in my work, and adopted the method of giving Passamaquoddy and English words consecutively on the cylinders.

The records were all numbered, and the announcement of the subject made on each in English. Some of the stories filled several cylinders, but there was little difficulty in making the changes necessary to pass from one to the other, and the Indians, after some practice, were able to "make good records" in the instrument. Thirty-six cylinders were taken in all. One apiece is sufficient for most of the songs and for many of the short stories. The longest story taken was a folk-tale, which occupies nine cylinders, about "Podump" and "Pook-jin-Squiss," the "Black Cat and the Toad Woman," which has never been published. In a detailed report of my work with the phonograph in preserving the Passamaquoddy language, I hope to give a translation of this interesting story.

Boston, U.S.A., March 20. J. WALTER FEWKES.

Solar Halos and Parhelia.

A MAGNIFICENT display of solar halos and parhelia was witnessed here this afternoon, exceeding in beauty and brilliancy that observed on January 29, 1890, and described in NATURE, February 6, p. 330.

The phenomenon was similar to the one of January 29, except that the mock suns were distinctly outside the first circle or halo, at a distance of 5° or 6°, and were when first seen at 3 p.m. *above* the level of the true sun; a handkerchief stretched at arm's length from one to the other gave the blurred image of the sun several degrees lower.

At 3.49 the patch of white light appeared about 90° from the right mock sun and connected to it with a *curved* band of white light, concave side upwards. The right mock sun must then have been *below* the level of the sun, as the band appeared to pass upwards through it to the sun. This band only remained a few minutes; the right sun and zenith arc at the time were most intensely brilliant, with the colours exceptionally clear and vivid. The zenith arc, and the patch of white light, were the last to disappear at 4.22.

The cirro-stratus cloud during and after the display was rapidly advancing from the north.

Driffield, April 9. J. LOVELL.

Cambridge Anthropometry.

I HAVE read with much interest, in NATURE of March 13 (p. 450), Mr. Venn's very interesting article on anthropometry at Cambridge.

There is in his tables one rather peculiar feature, of which I find no notice taken in the text. It will be seen on reference to the tables that, while the other physical characteristics increase from A to B, and from B to C (weight and height being irregular, however), the *breath* is highest in A, less in B, and least in C; thus falling with the intellectual fall.

It is true that the difference in this as in most of the other characteristics is so slight as to be—as Mr. Venn says—practically negligible; but still the fact that this should steadily *fall* instead of rising with the other physical characteristics strikes me as peculiar. I should be glad therefore to hear if Mr. Venn has any comment to make on this phenomenon, or any explanation thereof to suggest. F. H. P. C.

April 4.

A Remarkable Meteor.

ON Thursday, April 10, at 10.40 p.m., I observed a meteor of extraordinary brilliancy shoot from a point just east of β Leonis. It travelled over about 10° in a north-westerly direction, and was visible for fully two seconds. Its apparent diameter, as nearly as I can judge, was about a quarter of that of the full moon; its colour, a very vivid pale green. J. DUNN.

Much Marcle, Herefordshire, April 11.

Earthworms from Pennsylvania.

NEARLY twenty years ago, a very aberrant earthworm was described by a French naturalist, who obtained it from Pennsylvania. I should be greatly indebted to any naturalists or travellers who may find themselves in that part of the United States, if they would collect some of these worms and send them to me. The most convenient mode of transmission would be to pack the living worms in *moist* earth with moss or grass, in a tin box perforated at one end: this should be inclosed in a wooden box. Both small and large worms should be collected: some might be preserved in strong spirit, but living specimens would be the most useful. W. BLAXLAND BENHAM.

University College, London, April 10.

Crystals of Lime.

SINCE the appearance of my letter on this subject (p. 515) I have found that similar crystals have been recently observed by Mr. J. Joly, and were described by him in the Proceedings of the Royal Dublin Society, vol. vi. p. 255. H. A. MIERS.

SAMPLES OF CURRENT ELECTRICAL LITERATURE.[1]

THESE four books are samples of the different classes of text-books of the present day. The first, as its title implies, is intended for workmen actually engaged in the electrical industries, and is therefore of the non-mathematical technical order. The second, on the other hand, is intended for the practical man who is not afraid of a differential equation, and is a very suitable book for a student of one of the higher technical colleges. The third is a mathematical treatise of the University type; while the fourth is intended for the general public unacquainted with mathematical or scientific principles, but anxious to learn something about this electricity and its distribution, which are now constantly being referred to even in the daily newspapers.

Of the four books, the second, on "Absolute Measurements in Electricity and Magnetism," is the most valuable, because the information it contains is correct, and much of it is not to be found in other books. On opening the first book, "Short Lectures to Electrical Artisans," we anticipated seeing how Dr. Fleming had struck out an entirely new line; but we must confess our disappointment at finding that the author has such a veneration for the authority of antiquity that he felt compelled to commence this book with a description of the loadstone. These lectures, we are told in the preface to the first edition, are on "subjects connected with the principles underlying modern electrical engineering," and were delivered "to the pupils and workmen associated with" Mr. Crompton's firm at Chelmsford. We presume, then, that the lectures were intended to enable workmen to make better dynamo machines, electromotors, &c., but as we never yet met with a piece of loadstone in any electrical factory in England or the Continent, we fail to see how the purpose of the lectures was served by their starting with an account of the "native oxide of iron" called the loadstone. Neither the loadstone nor the classical lump of amber, so dear to the hearts of the writers of electrical text-books, are workshop tools. The latter a workman may perhaps come into contact with as a mouthpiece to his pipe, but a piece of loadstone he will probably never even see out of the lecturer's hand. Apart from this academic start, Lecture I. is decidedly good; the author, for example, not merely mentions that an alloy of steel with 12 per cent. of manganese is nearly non-magnetic, but he gives the name and address of the firm from whom manganese steel can be obtained, and he follows the same wise course when explaining how ferro-prussiate photographic paper may be used for obtaining permanent records of magnetic lines of force.

But why give Rowland's curve connecting permeability and magnetic induction, since later experiments have shown that this curve is quite wrong for large magnetic inductions? The same mistake is made in Lecture III., where it is assumed that for a certain magnetizing force iron becomes saturated, so that no greater induction can be produced, no matter how much the magnetic force is increased.

Lectures II. and III. have many blemishes. The expression 50 ampères of current, on p. 24, is misleading; you cannot have 50 amperes of anything else but current. An ampere is the English name for a unit of current; why, then, put a grave accent over the name? One might as well in speaking of so many metres give this last word its French pronunciation? In justice, however, to Dr. Fleming, we should mention that the use of the grave accent over the word *ampere*, when used in English, is not peculiar to him. We wish, however, that he had been bold enough to Anglicize this word. In describing the construction of a simple mirror galvanometer, the *technical* reader ought to have been warned that, unless, in sticking the three magnets on the back of the mirror with shellac varnish, the shellac be put just at the middle only of each magnet, the mirror will be distorted and rendered useless. To say, when speaking of the induction of a current in a secondary coil by the starting or stopping of a current in the primary, that the interposition of "a plate of iron prevents it altogether," shows that the author has never tried the experiment.

On p. 30 is given a picture of the apparatus the author employs for ascertaining the laws of the production of a current in a coil by the insertion or withdrawal of a magnet. The magnet that is being moved has, judging from the figure, at least 1000 times the mass of the needle of the galvanometer, which is attached by two *very short* wires to the coil in which the current is induced. If an electrical artisan were to perform this experiment with the apparatus placed as in Fig. 17 of Dr. Fleming's book, he would probably ascertain the laws of magneto-electric induction with the same amount of accuracy as we once saw obtained at a lecture where the decisive, and applause-producing, swings of the galvanometer needle, on suddenly bringing up the magnet to the coil and removing it again, were certainly produced by the *direct* action of the magnet on the galvanometer needle, since it was observed at the close of the lecture that one of the wires going from the coil to the galvanometer had never been connected with the galvanometer terminal. And the same sort of criticism applies to Fig. 28, p. 57, representing the arrangement of apparatus for measuring the magnetization of the iron core of an electro-magnet by a current passing round its coil. The reader is told that the magnetometer, which is, of course, to be directly affected by the magnetism of the iron bar, is, for some reason unexplained in the book, to be put at a considerable distance from the bar, but he is not warned that the meter used for measuring the current passing round the electro-magnet (and which, of course, ought not to be directly affected by the magnetism of the bar) must on no account be placed, as in this figure, close to the powerful magnet.

On p. 32 the author says that a core of soft iron "acts like a lens, and concentrates or focusses more lines of force from the magnet on the primary coil through the aperture of the secondary." But this simile with a lens is but a repetition of an old error; a lens simply bends rays of light, and, so far from adding to the total amount of light, actually slightly diminishes this amount by absorption. A lens for light is like a funnel for a fluid, it directs the stream along a narrow channel, so that while the flow is on the whole diminished by friction the flow along a certain cross-section is much increased. But the insertion of an iron core into a coil traversed by a current vastly increases the *total* number of lines of force. The solenoid without the iron core is like a cistern with water in it which is being emptied with a pipe full of dirt, through which the water can only trickle; and the insertion of the iron core into the solenoid is like the cleaning out of the pipe, so that the stream of water now becomes vigorous and rapid. Even Dr. Fleming knocks his own simile on the head, for he states 27 pages further on, "The joint effect of the" (iron) "bar and coils is the sum of the effects of each separately." Fancy anyone saying that the joint effect of a lens and a candle was the sum of the effects of each separately.

We consider it archaic for Dr. Fleming to define the volt for practical men as the E.M.F. generated in one centimetre of wire moving with a velocity of one centimetre per second in a magnetic field of unit force. As well

[1] "Short Lectures to Electrical Artisans." 2nd Edition. By J. A. Fleming. (London: E. and F. N. Spon, 1888.)
"Absolute Measurements in Electricity and Magnetism." 2nd Edition. Revised and greatly Enlarged. By Andrew Gray. (London: Macmillan and Co., 1889.)
"The Theory and Practice of Absolute Measurements in Electricity and Magnetism." By Andrew Gray. (London: Macmillan and Co., 1888)
"Electricity in Modern Life." By G. W. de Tunzelmann. (London: Walter Scott, 1889.)

might a kilogramme be defined for a French butcher as the weight of a cubic decimetre of distilled water at 4° C., and the butcher's business be absolutely stopped because he did not possess any distilled water and because the temperature of his shop was 20° and not 4° C. In fact, Lectures II. and III., although containing a large amount of valuable information, are professorial rather than practical.

On p. 74 a Ruhmkorff induction coil is correctly described, but in Fig. 36 on the same page the primary coil, with the vibrating interrupter and four cells in its circuit, is shown as consisting of many convolutions of fine wire, and the secondary of a few turns of thick wire. On p. 83 one centimetre is given as equal to 0·0328087 of a foot—that is, correct to *six significant figures*—while even in the second edition, "the call" for which "has afforded the opportunity to erase several typographical errors and to remove some other blemishes which had escaped notice and correction in the first edition," the previous statement is *immediately* followed by the announcement that one inch equals 2·500 centimetres, an equation which is only correct to *two significant figures*, the number expressed correctly to six significant figures being 2·53995. But why not use 2·5400, the value commonly adopted, and which is correct to four places of decimals? As a further example of the want of precision which runs through this book, it may be mentioned that on p. 9 a falling body acquires per second a velocity of 981 centimetres per second. Throughout the whole of p. 85, where the number is frequently mentioned, the body, as if a little tired, cannot get up a velocity of more than 980 centimetres a second. Proceeding, however, to the next page, the body, like the reader, turns over a new leaf, and hurries up its speed, for it acquires per second a velocity of 981 centimetres per second all through this page. Further on, however, in the book, the poor falling body gets tired again, for on p. 97 it cannot do more than the 980. On p. 87 we find the statement, "Hence one foot-pound = 1·356 *joules*, or one joule = ·7373 foot-pound," whereas a simple division shows that if the first part of the statement be correct, the second is not.

To say that "the work is numerically measured by the product of the displacement and the mean stress estimated in the direction of the displacement" is learned and academical, but might not the poor electrical artisan mix this up with the displacement of the factory hands that usually occurs when there is no stress of work?

On p. 99 it is stated that the "E.M.F. of Clark's cell = 1·435 true volt," but, as no indication has been given in this book that there is more than one volt, we are left in ignorance of the reason why the volts used to measure the E.M.F. of a Clark's cell have to be *so especially true*, and why 10^9 C.G.S. units, which is the volt that has been previously used, is not good enough for this sort of measurement. On looking in the index for the definition of the "Ohm British Asssociation," we find ourselves referred to p. 136, and the reader is left to wonder what is a "B.A.U." of resistance used some forty pages previous to this. Similarly the "Legal Ohm" is spoken of and its value given in terms of a "B.A.U." thirty-seven pages before the reader is told what a "Legal Ohm" is. For this the arrangement of the book and not the index is, of course, to blame. And while on this subject we should like to point out that the indexes of scientific books appear to furnish a conclusive proof of the inherent modesty of scientific writers. Take up some large and important treatise, and turn to the index. There you are told that the book contains almost nothing. On the title-page the publisher may have indiscreetly added after the author's name line after line of small print enumerating the various scientific and unscientific societies to which the author belongs, but in the index all pretension to such a wide acquaintance with science is disclaimed. You may have a distinct recollection of reading in this very book many pages on some special subject, but rack your brains as you will to discover under what heading in the index this subject may have been entered, not a reference to it can you find. Accumulators, storage cells, transformers, the volt, voltmeters, &c., seemed likely subjects to be treated on in "Short Lectures to Electrical Artisans," but the index says no; and it is only by carefully reading through the book that you discover that it contains much valuable information on these very points. We would suggest to the writers of scientific treatises, and also to those who communicate scientific papers to learned societies, that the practical man of to-day cannot possibly afford the time to read through ninety-nine things that he does not want to know about, before he can light on the one thing regarding which he is searching for information.

In speaking of Messrs. Crompton and Kapp's meter, on p. 115, Dr. Fleming says:—

"The only difficulty which arises in connection with such an instrument as this, is the tendency of a long thin iron wire of this kind to retain strongly residual magnetism and fail to de-magnetize itself, but this effect would only prevent the return of the indicating needle to zero when the current was stopped, but would not prevent the instrument from giving a definite and fixed deflection corresponding to a definite and fixed current passing through the coils." It was no doubt a somewhat delicate task for Dr. Fleming when lecturing to Mr. Crompton's staff to fully criticize Mr. Crompton's meters, but since actual published experiments on some of these meters show that, for the low readings, the apparent value of a given current differs by as much as 10 per cent., depending on whether the current is ascending or descending, we fail to see how the scientific knowledge of any artisans can be improved by their being told that no such error exists.

Fig. 50, p. 122, showing the level of the columns of water in stand-pipes attached to a horizontal tube through which water is flowing, was never drawn from an actual apparatus. The author has forgotten that the water has not merely to flow through the horizontal tube A*a*, but through the much longer vertical tube CA, and therefore, there is a much greater difference of level between the height of the water in the cistern and in the first stand-pipe, *aa'*, than there is between the level in this stand-pipe and in the next, *bb'*. If Fig. 50 were correct, it would follow that when a battery of even *large internal resistance* was sending a considerable current the difference of potentials at its terminals was equal to the E.M.F. of the battery. Not merely, then, is this opportunity lost of explaining to the readers that the difference of potentials at the terminals of a battery may be very much less than the E.M.F., but the information conveyed by the diagram is actually contrary to fact.

The statement that "Storage cells for lighting purposes cease to give a useful discharge when the electromotive force falls below two volts" is hardly consistent with the fact that, when storage cells are discharged at the current that is considered quite safe by the Electrical Storage Power Company, the E.M.F. for nine-tenths of the period of the discharge is slightly below two volts.

We have said enough to show that, although the book called "Short Lectures to Electrical Artisans" is written by one who, from his University and factory experience, has a large amount of valuable information at his command, the second edition reads far too much like an uncorrected proof of the first edition; and instead of the statements it contains possessing weight because they are made in the book, there is an uneasy feeling when reading its pages that any statement may be wrong, and requires to be checked. We trust, however, that the sale of this, the second edition, may be large and rapid, so that the author may have an opportunity of shortly bringing out as a third edition a book more worthy of his acknowledged power.

"Absolute Measurements in Electricity and Magnetism," by Prof. A. Gray, is a most interesting book to read. It opens with a detailed description of Gauss's methods for determining the horizontal intensity of the earth's magnetism, and with an account of the results of the measurement of the variation, produced by a unit field, on the magnetic moments of steel magnets of different sizes tempered to different degrees of hardness. If it be desired to determine the magnetic moment of a bar-magnet as well as the horizontal intensity of the earth's magnetism, which is of course necessary when variations of the magnetic moment of a bar are in question, Gauss's methods are admirable. But if the value of H is all that is needed, then the simpler method of employing an earth inductor with a ballistic galvanometer, which is described on pp. 317-21, might well be employed. It would, therefore, have been well to give a reference to this method in the first two chapters, which are mainly devoted to the determination of H.

Next follows a concise statement of the various ways of defining the absolute current, and a fairly complete chapter on standard galvanometers. In Chapters IV. and V., and in Chapter XI., to which reference is made, there is given the ablest description of the dimensions of the electric and magnetic units that we have ever read. It is both correct and comprehensible, which is saying a very great deal for an exposition of a subject which, as usually explained, generally leaves even a thoughtful student semi-dazed as to whether the dimensions are the dimensions of the unit, or the dimensions of a quantity measured in the unit. Indeed, the early reports of the Electrical Standards Committee of the British Association were actually wrong on the very subject of dimensions, so that "*v*" was regularly defined as the ratio of the electrostatic to the electromagnetic unit of quantity instead of as the reciprocal of that expression.

The volt, ohm, ampere, coulomb, watt, and joule are also explained and defined in Chapter V., and Prof. Gray gives Sir W. Thomson's expression "activity" for the rate of doing work. He does not mention, however, that the equally short word "power" is regularly employed with this signification.

Chapter VI. is devoted to the laws of the currents sent by galvanic cells through single and parallel circuits, and through any branch of a network like that of the Wheatstone's bridge. A neat proof is given of the arrangement of a given number of cells that sends the greatest current through a fixed resistance, and the reader is very properly warned against confusing the arrangement which develops maximum power with the most economical arrangement.

In Chapter VII. we have a complete description of Sir William Thomson's meters, but, as the book is a scientific treatise (in fact, a very good scientific treatise) and not an instrument-maker's catalogue, we think that the author would have done himself more justice had he described, in addition, some of the other many forms of electric meters in common use at the present day for carrying out the same measurements. Further, in view of the large experience that the author of this book has probably had with Sir W. Thomson's meters, it would have been well had there been a description not merely of the advantages of these instruments, but also of their disadvantages, a subject no one would be more willing to discuss than the inventor himself. On pp. 133-35 is given a very simple proof of the ordinary formula for the quadrant electrometer, but the reader is not here warned that the formula may give an answer many per cent. wrong in practice. On p. 302 it is stated that this formula may be slightly wrong if the aluminium needle of the electrometer be not accurately adjusted relatively to the quadrants, but this, we fear, is rather misleading, since it is further stated that "if the needle hangs at its proper level, and is otherwise properly adjusted, and the quadrants are close, the equation may be taken as accurate enough for practical purposes," a conclusion regarding which we understand there is grave doubt. In this chapter the very important subject of calibrating instruments by the use of the silver or the copper voltameters is fully entered into. The large amount of valuable work done on this subject by the author's brother, Prof. T. Gray, of which a description is given, endows this chapter with an authoritative character.

Chapter VIII. commences with the construction and use of the various forms of Wheatstone's bridges, the description of the modes of using them, and hints as to the care of a resistance box. The methods for calibrating relatively and absolutely the wire of a bridge devised by Matthiessen and Hockin, Foster, T. Gray, and D. M. Lewis are discussed at length, and specimens given of the actual results obtained at University College, North Wales, by the use of these methods. The ingenious bridges, which have been arranged by Sir W. Thomson, Matthiessen and Hockin, Tait and T. Gray, for measuring very low resistances, are fully entered into, and the construction of standard coils, the measurement of high resistances, and of the resistance of a battery finish a chapter of especial interest. The method of measuring the resistance of a battery, proposed several years ago by Sir Henry Mance, is condemned by Prof. Gray as being "so troublesome as to be practically useless," on account of "the variation of the effective electromotive force of the cell produced by alteration of the current through the cell which takes place when the key is depressed." We think that it should have been stated that this is not a defect especially of Mance's method, but of *all* methods for measuring the resistance of a battery based on the alteration of a steady current by the alteration of the resistance in the battery circuit. Would it not also here have been well to describe and discuss the condenser method of measuring a battery resistance, as it is the one to which the fewest objections can be raised?

Good as are all the chapters in this book, the next one, Chapter IX., on "The Measurement of Energy in Electric Circuits," is so good that it takes the palm. It commences with the practical methods of measuring the power and efficiency of motors and secondary batteries; the construction and employment of activity meters (watt-meters); and then discusses very fully the laws of alternate currents, the mathematical theory of alternate current generators singly, or coupled in parallel or in series; the theory of the action of an alternate current generator supplying current to an alternate current motor; the true method of measuring the power given to any circuit by an alternate current; and the error produced when an ordinary watt-meter is employed. The work of Joubert, Hopkinson, Potier, Ayrton and Perry, and Mordey on this subject is summed up in a masterly fashion. Chapter IX. is, in fact, the most complete exposition of many problems connected with the all-important subject—the electrical transmission of energy by *alternate* currents—that is to be found in any existing text-book, and especially in a small octavo text-book, that can be easily carried in one's coat pocket.

In Chapter X. the measurement of intense magnetic fields is dealt with, and a description is given of ingenious methods proposed by Sir W. Thomson for measuring the force on a conductor conveying a known current placed in the magnetic field, and so determining the strength of the field. The ordinary method of ascertaining the strength of a magnetic field by suddenly withdrawing a coil, of known area and number of convolutions, attached to a ballistic galvanometer, is described. But in order to ascertain the constant of the ballistic galvanometer, the author only gives the old method of observing the swing of the needle when a large coil is turned in the earth's field, a method which necessarily requires for its employment a previous knowledge of the strength of the earth's field at the place. A far simpler method of ascertaining the constant of a ballistic galvanometer is to charge a condenser of known capacity with one or more Clark's cells, of which the E.M.F. at any ordinary temperature is now well known, and discharge the condenser through the ballistic galvanometer; or, if a sufficiently delicate ampere-meter be available, the ballistic galvanometer may be very accurately calibrated for steady currents, and then its constant for a sudden discharge is at once known by simply measuring, in addition, the periodic time of vibration of the needle and its logarithmic decrement.

The book concludes with an appendix giving the decisions arrived at in 1886 by the Electrical Standards Committee of the British Association, and the further resolutions which were passed at the meeting of the Electrical Congress in Paris last year, and subsequently agreed to by the British Association Committee. Then follow twelve sets of useful tables.

Although we have made a few suggestions that the author may perhaps like to adopt in publishing the third edition of his "Absolute Measurements in Electricity and Magnetism," we desire to emphasize our warm appreciation of this the second edition. On every page may be seen evidences of the firm grip of the subject so characteristic of the author's teacher—the teacher, in fact, of us all—Sir William Thomson; and did we know of higher praise than this we would give it.

"The Theory and Practice of Absolute Measurements in Electricity and Magnetism, Vol. I.," also by Prof. A. Gray, is a mathematical expansion of the *electrical* portion of his book on "Absolute Measurements, &c.," the mathematical treatment of the *magnetic* portion being reserved for Vol. II. of the larger work. As many of the remarks that we have already made regarding the smaller work apply equally well to the larger, it is unnecessary to criticize the larger book at any considerable length. The two books may be read quite independently of one another, since much of the descriptive matter is the same in both. If there be a fault in the larger work, we think that it arises from the author forgetting that a book intended initially for the University student can also be made of great value to the more practical electrician if first the subject-matter be arranged in propositions, or with distinct headings to the paragraphs, so that it is easy to find the proof of any particular fact; and, secondly, if complete proofs be given of important practical problems, instead of simply deducing them as special cases of more general problems. For example, a practical electrician may desire to see how the logarithmic formula for the capacity of a cable is arrived at. Now, there is no difficulty in giving a fairly short complete proof of this; but, on turning to Prof. Gray's "Theory and Practice, &c.," the electrician finds that he must first master the theory of charged ellipsoids; he sees several double integrals and several lines of long mathematical formula in small print, and he probably decides that he had better pass by that subject for the present. We hold that, since the pure science of electricity owes so much to its practical development, it is but fair that the pure mathematician should endeavour to repay this debt by stating his results and methods of proof in such a form that they can be most easily grasped by anyone who desires to use them, and not merely to get up the subject for examination purposes. The general mathematical investigations are also, of course, of great value, and we are therefore glad to see in this book a fairly complete mathematical treatment of Green's theorem, inverse problems, electric images, problems of steady flow in non-linear conductor, and variable linear flow, with its application to the speed of signalling in submarine conductors.

Very interesting information is given regarding the strength and torsional rigidity of the fine silk fibres used in suspending galvanometer needles, followed by the mathematical theory of oscillations, the description of the practical methods of measuring periodic times of oscillation and moments of inertia, and concluding with a comparison of unifilar and bifilar suspensions. The succeeding chapters on electrometers, the general measurement of resistance, the calibration of the wire of a metre bridge, the measurement of very low resistances, the measurement of very high resistances, the determination of specific resistance, contain what is given on these subjects in the smaller book amplified.

The last chapter, No. VIII., in this larger treatise, on capacity, is very complete. It gives a description of the most important investigations that have been made on the specific inductive capacity of solids, liquids, and gases, together with the mathematical theory of each experiment.

Although we cannot but feel that the smaller of the two books published by Prof. A. Gray is the more unique, the larger is a very creditable production, and will be valuable as a book of reference for those who desire to consult a shorter book on mathematical electricity than that of Messrs. Mascart and Joubert.

We now come now to the fourth book, "Electricity in Modern Life," by Mr. de Tunzelmann, which is written on an excellent basis, and contains a great deal of useful popular information, but it unfortunately also contains many unnecessary errors. For example, the statement on p. 11, that "a single cell of this kind," potash bichromate, "holding about a quart of solution, is capable of maintaining the light of a small incandescent lamp for some three or four hours," would rather disappoint a purchaser of a quart, or any size, bichromate cell, as he would find it most difficult to purchase an incandescent lamp that would glow with so small a difference of potential as *one* cell could produce. Again, to say in Chapter II., on "What we Know about Magnetism," "Weber's theory of magnetism may now be considered as raised from the rank of an hypothesis to that of an established fact," gives a totally wrong idea as regards our knowledge, or, rather, as regards our ignorance, of the mechanism of magnetism. "The face of the magnet that before pointed to the north," &c., is not exactly wrong; but can a face point towards anything? "If a current goes round the solenoid in the direction of the hands of a watch with its face directed towards the end from which the current flows, the end of the steel bar within the end of the solenoid at which the current leaves will be found to be a north pole and the other end a south pole," would lead the reader to imagine that the polarity of the core of an electromagnet depended partly on the direction in which the current flows *parallel* to the core, instead of depending, as is the fact, wholly on the way it flows *round* the core.

Chapter IV., on "Force, Work, and Power," is good, and the careful distinction drawn between work and power is forcible and apt. But why does the author limit the definition of a horse-power, 33,000 pounds raised 1 foot per minute, to the "indicated horse-power" of a steam-engine.

Chapter V. deals with the "Sources of Electricity." In describing the chemical action of a galvanic cell formed "of a plate of zinc and a plate of copper partly immersed in sulphuric acid," it is an obvious mistake to speak of the action as a simple liberation of hydrogen at the copper plate, and oxygen at the zinc, and to omit all reference to the formation of zinc sulphate. The first part of the following statement has been experimentally disproved some fifteen years ago:—"If either the copper or zinc is immersed alone in dilute sulphuric acid, a difference of potential will be produced between the metal and the liquid; but if the two metals are immersed side by side into the liquid, then no electrification can be detected." A galvanic battery is defined by the author as "a series of galvanic cells so arranged that the zinc of each cell is connected with the copper of the next cell." What, then, is a collection of galvanic cells arranged in parallel, in which the zinc of every cell is connected with the zinc and not with the copper of the next? Excluding these mistakes, this chapter is fairly good; the matter, however, is rather too condensed to be intelligible to a reader not previously acquainted with the subject.

Chapter VI. deals with "Magnetic Fields," and in order to lead up to the mapping out of a magnetic field, the mapping out of the gravitation field of force in which a comet moves is first explained. But it appears to us that, since the magnetic field can be easily mapped out with iron filings in the well-known way, while the conception of a gravitation field of force is a less simple matter to grasp, Mr. de Tunzelmann has in this case explained the easy by means of the difficult.

The next chapter, on "Electrical Measurement," is quite correct, but, in view of the great difficulty that is always experienced by a beginner in grasping the idea of measuring so intangible a thing as electricity, would not this subject have been made clearer if not merely the scientific definitions of the electrical units had been given, but in addition an illustrated description of the meters used to measure amperes, volts, &c.?

Chapter VII., on "Magneto and Dynamo Electric Machines," gives a short comprehensive description of the principles of these machines, but, in order that the reader might understand what a real dynamo was like, we think it would have been better if the author had given in this chapter at least some one of the illustrations representing real dynamos which appear in other parts of this book. The symbolical figures that are given are, as the author mentions, taken from Dr. Thompson's book on dynamo machinery, and are very clear, with one exception, that while in each case the direction of the current in the wires attached to the brushes is indicated by arrows, the direction in which the wire is coiled on the armature is omitted, hence such statements as "the arrows show the current in the circuit when the armature revolves as indicated by the position of the brushes," are just as likely to be wrong as right, and tell the reader nothing. When comparing the series dynamo with the shunt dynamo, the author says that the former "will not begin to excite itself until a certain speed has been obtained depending on the resistance of the circuit." From this the reader might easily be misled into thinking that the shunt machine did not possess a similar defect. Further, he states, as "the principal objection to shunt-wound machines," that the self-induction of the field-magnet coils leads to the result that "any variation in the speed produces its effect upon the lamps before the current in the existing circuit has had time to undergo a sensible change." But, as a matter of fact, the self-induction of the field-magnet coils of a shunt machine is an *advantage*, not a *disadvantage;* for suppose that the speed increases, then the E.M.F. increases, this causes the difference of potentials between the lamp-mains to increase, which not only sends a larger current through the lamps, but also through the shunt coils. This strengthening of the field causes an additional rise in the E.M.F. of the machine, and therefore in the terminal difference of potentials. Consequently the second objectionable rise is hindered, and not accelerated, by the self-induction of the shunt coils; hence self-induction of the field-magnet coils of a shunt machine makes the difference of potentials between the lamp-mains less quickly, and not more quickly, affected by a change in the speed of driving. In speaking of alternate-current dynamos, it is stated that "in some machines the armature remains at rest, and the field-magnets are made to rotate; and in this case no sliding contact is required, the terminals of the main circuit being attached permanently to the armature." But the statement is misleading, since at least one sliding contact must *always* be used; only when the armature is fixed it is to lead the exciting current into and out of the rotating field-magnets that one, and in some cases two sliding contacts are employed.

Chapters IX., X., and XI., on "The Story of the Telegraph," "Overland Telegraphs," and on "Submarine Telegraphs," are excellent, we may almost say exciting, and they lead the reader on like the pages of a well-written novel. It is not right, however, on p. 112 to say, when speaking of telegraphing with sounders, "The dots are formed by giving a sharp stroke to the key; the dashes by depressing it more slowly," since a dash is formed not by depressing the key slowly, but by holding it down for a time when depressed. Whether a key be depressed slowly or quickly makes no difference in the signal received; what the receiver listens for is the interval between the commencement of the current produced when the key is fully depressed and its termination when the key is caused to begin to rise again. We presume that when the author says, on p. 129, "The cups" of insulators "are made of such a form as to expose the upper portions freely to the cleansing action of the rain while the lower portions are shielded from the rain so as to keep them fairly dry," he means by "upper portions" the *outside* of the cup of the insulator, and by the "lower portions" the *inside;* but if so, he has a curious way of expressing himself. The "speaking galvanometer" used in receiving the message sent through a submarine cable is not, as the author describes it on p. 150, an astatic galvanometer; and even if two magnets were employed so as to form an astatic combination, it would be quite wrong to say "each of them is attached to the back of a small mirror," since, unnecessary as it would be to use two suspended magnets in a speaking galvanometer, it would be still more useless to employ two suspended mirrors. But these are not very serious errors in chapters that are so good.

Chapters XII. and XIII., on "The Telephone" and "The Telephone Exchange System," appear to us to be too much of the newspaper special correspondent order, the descriptions in several cases being very meagre, suggestive rather than descriptive, in consequence of the author having attempted to touch on too many different things. For instance, if the photophone had to be described at all, it required more than one page and a quarter, inclusive of the illustration, to make it intelligible; in fact, unless the framework of the telephones and the gentleman's head which is between them in Fig. 53 are all composed of electrically conducting material, we fail to see how the instrument, as there depicted, works at all. Some very interesting information is given on the subject of telephone exchanges, and we should have liked to have had much more information on this electrical subject; for example, greater details regarding the switches, the reasons of the babble of many conversations that everyone hears who tries to use the telephone in London, &c.; space, if necessary, being economized by the omission of the description of the non-electrical instruments, the graphophone and phonograph.

Chapter XIV., on the "Distribution and Storage of Electrical Energy," is very good and forcible. We fail, however, to see how the use of the three-wire system leads to the result stated on p. 199, that "a variation of 5 per cent. in the E.M.F. in the mains would produce a variation of only 2½ per cent. at the lamp terminals."

The next chapter, XV., on "Electric Lighting," is also very good; "flashing" the filament of an incandescent lamp, however, does not mean sending a current through the filament while the lamp is attached to the Sprengel pump, but sending a current through the filament and making the filament incandescent when in a hydrocarbon atmosphere before it is placed inside the glass bulb of the lamp. Is it a fact that "the Shaftesbury theatre" is "now lighted by incandescent electric lamps?"

The chapter on "Electro-Motors and their Uses" is good considering how much may be said on this subject and how short a space is 14 pages to say it in. By what means, however, Messrs. Immisch have succeeded in making the dogcart for the Sultan of Turkey go "ten miles an hour for about five hours" by means of "twenty-four small accumulators which weigh about seven hundredweight" we are at a loss to conceive, since the weight of accumulators, according to our calculation, must be much greater than this in order that they may have anything like a reasonably long life.

Chapter XVII., on "Electro-Metallurgy," is interesting although very brief, but the descriptions of the electrical circuit-closers for torpedoes in the next chapter, on "Electricity in Warfare," we find too short to be intelligible. A chapter of 5 pages then follows on "Medical Electricity," and another chapter of the same length on "Miscellaneous Applications of Electricity," in which a very interesting account is given of the electrical method employed in America for protecting furnished dwelling-houses that have been left locked up during the absence of the tenants.

On closing this book one certainly cannot deny that one has had one's money's worth, even if the entertainment has been of the "variety order" so characteristic of the amusements of the present day. If a member of the general public will read the book right through, as we have done, he may perhaps feel with exultation that he has mastered the whole subject of electrical engineering; indeed, even a well-trained electrician can learn from it many things that he did not know before, concerning those branches of the subject to which he has not given special attention. But we fear that, if even a general reader were to turn up any particular subject to study in detail, he would probably wish he had been told a good deal more about what was most important, and not so much about everything electrical whether important or not. The best features of "Electricity in Modern Life" are the many interesting scientific narratives, in the writing of which Mr. de Tunzelmann appears to excel; the worst are the mistakes in the science, which more knowledge, or more care, ought to have eliminated.

ON THE TENSION OF RECENTLY FORMED LIQUID SURFACES.[1]

IT has long been a mystery why a few liquids, such as solutions of soap and saponine, should stand so far in advance of others in regard to their capability of extension into large and tolerably durable laminæ. The subject was specially considered by Plateau in his valuable researches, but with results which cannot be regarded as wholly satisfactory. In his view the question is one of the ratio between capillary tension and superficial viscosity. Some of the facts adduced certainly favour a connection between the phenomena attributed to the latter property and capability of extension; but the "superficial viscosity" is not clearly defined, and itself stands in need of explanation.

It appears to me that there is much to be said in favour of the suggestion of Marangoni ("Nuovo Cimento," vols. v.–vi., 1871, p. 239), to the effect that both capability of extension and so-called superficial viscosity are due to the presence upon the body of the liquid of a coating or pellicle composed of matter whose inherent capillary force is less than that of the mass. By means of variations in this coating, Marangoni explains the indisputable fact that in vertical soap films the effective tension is different at various levels. Were the tension rigorously constant, as it is sometimes inadvertently stated to be, gravity would inevitably assert itself, and the central parts would fall 16 feet in the first second of time. By a self-acting adjustment the coating will everywhere assume such thickness as to afford the necessary tension, and thus any part of the film, considered without distinction of its various layers, is in equilibrium. There is nothing, however, to prevent the interior layers of a moderately thick film from draining down. But this motion, taking place as it were between two fixed walls, is comparatively slow, being much impeded by ordinary fluid viscosity.

In the case of soap, the formation of the pellicle is attributed by Marangoni to the action of atmospheric carbonic acid, liberating the fatty acid from its combination with alkali. On the other hand, Sondhauss (*Poggendorff's Annalen*, Ergänzungsband viii., 1878, p. 266) found that the properties of the liquid, and the films themselves, are better conserved when the atmosphere is excluded by hydrogen; and I have myself observed a rapid deterioration of very dilute solutions of oleate of soda when exposed to the air. In this case a remedy may be found in the addition of caustic potash. It is to be observed, moreover, that, as has long been known, the capillary forces are themselves quite capable of overcoming weak chemical affinities, and will operate in the direction required.

A strong argument in favour of Marangoni's theory is afforded by his observation,[1] that within very wide limits the superficial tension of soap solutions, as determined by capillary tubes, is almost independent of the strength. My purpose in this note is to put forward some new facts tending strongly to the same conclusion.

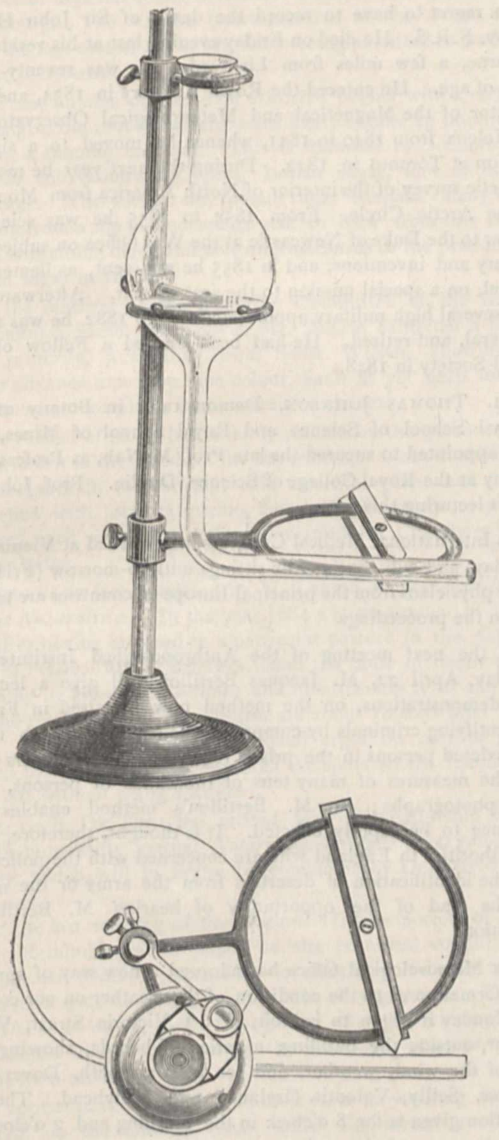
It occurred to me that, if the low tension of soap solutions as compared with pure water was due to a coating, the formation of this coating would be a matter of time, and that a test might be found in the examination of the properties of the liquid surface immediately after its formation. The experimental problem here suggested may seem difficult or impossible; but it was, in fact, solved some years ago in the course of researches upon the capillary phenomena of jets (Roy. Soc. Proc., May 15, 1879). A jet of liquid issuing under moderate pressure from an elongated, *e.g.* elliptical, aperture perforated in a thin plate, assumes a chain-like appearance, the complete period, λ, corresponding to two links of the chain, being the distance travelled over by a given part of the liquid in the time occupied by a complete transverse vibration of the column about its cylindrical configuration of equilibrium. Since the phase of vibration depends upon the time elapsed, it is always the same at the same point in space, and thus the motion is *steady* in the hydrodynamical sense, and the boundary of the jet is a fixed surface. Measurements of λ under a given head, or velocity, determine the time of vibration, and from this, when the density of the liquid and the diameter of the column are known, follows in its turn the value of the capillary tension (T) to which the vibrations are due. *Cæteris paribus,* $T \propto \lambda^{-2}$; and this relation, which is very easily proved, is all that is needed for our purpose. If we wish to see whether a moderate addition of soap alters the capillary tension of water, we have only to compare the wave-lengths λ in the two cases, using the same aperture and head. By this method the liquid surface may be tested before it is $\frac{1}{100}$ second old.

Since it was necessary to be able to work with moderate quantities of liquid, the elliptical aperture had to be rather fine, about 2 mm. by 1 mm. The reservoir was an ordinary flask, 8 cm. in diameter, to which was sealed below as a prolongation a (1 cm.) tube bent at right angles (Figs. 1, 2). The aperture was perforated in thin sheet brass, attached to the tube by cement. It was about 15 cm. below the mark, near the middle of the flask, which defined the position of the free surface at the time of observation.

[1] A Paper read by Lord Rayleigh, Sec.R.S., before the Royal Society, on March 6.

[1] *Poggendorff's Annalen*, vol. cxliii., 1871, p. 342. The original pamphlet dates from 1865.

The arrangement for bringing the apparatus to a fixed position, designed upon the principles laid down by Sir W. Thomson, was simple and effective. The body of the flask rested ont hree protuberances from the ring of a retort stand, while the neck was held by an india-rubber band into a V-groove attached to an upper ring. This provided five contacts. The necessary sixth contact was effected by rotating the apparatus about its vertical axis until the delivery tube bore against a stop situated near its free end. The flask could thus be



FIGS. 1 and 2.

removed for cleaning without interfering with the comparability of various experiments.

The measurements, which usually embrace two complete periods, could be taken pretty accurately by a pair of compasses with the assistance of a magnifying glass. But the double period was somewhat small (16 mm.), and the little latitude admissible in respect to the time of observation was rather embarrassing. It was thus a great improvement to take magnified photographs of the jet, upon which measurements could afterwards be made at leisure. In some preliminary experiments the image upon the ground glass of the camera was utilized without actual photography. Even thus a decided advantage was realized in comparison with the direct measurements.

Sufficient illumination was afforded by a candle flame situated a few inches behind the jet. This was diffused by the interposition of a piece of ground glass. The lens was a rapid portrait lens of large aperture, and the ten seconds needed to produce a suitable impression upon the gelatine plate was not so long as to entail any important change in the condition of the jet. Otherwise, it would have been easy to reduce the exposure by the introduction of a condenser. In all cases the sharpness of the resulting photographs is evidence that the sixth contact was properly made, and thus that the scale of magnification was strictly preserved. Fig. 3 is a reproduction on the original scale of a photograph of a water-jet taken upon November 9. The distance recorded as 2λ is between the points marked A and B, and was of course measured upon the original negative. On each occasion when various liquids were under investigation, the photography of the water-jet was repeated, and the results agreed well.

After these explanations it will suffice to summarise the actual measurements upon oleate of soda in tabular form. The standard solution contained 1 part of oleate in 40 parts of water, and was diluted as occasion required.[1] All lengths are given in millimetres.

	Water.	Oleate 1/40.	Oleate 1/80.	Oleate 1/400.	Oleate 1/4000.
2λ	40·0	45·5	44·0	39·0	39·0
h	31·5	11·0	11·0	11·0	23·0

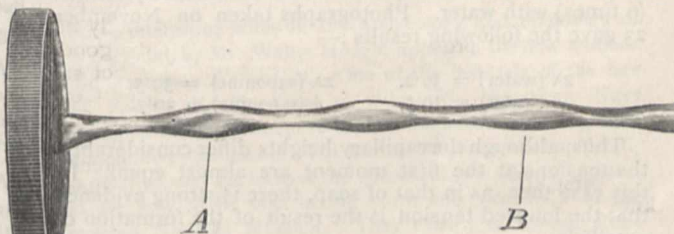


FIG. 3.

In the second row h is the rise of the liquid in a capillary tube, carefully cleaned before each trial with strong sulphuric acid and copious washing. In the last case, relating to oleate solution $\frac{1}{4000}$, the motion was sluggish and the capillary height but ill-defined. It will be seen that even when the capillary height is not much more than one-third of that of water, the wave-lengths differ but little, indicating that, at any rate, the greater part of the lowering of tension due to oleate requires time for its development. According to the law given above, the ratio of tensions of the newly-formed surfaces for water and oleate ($\frac{1}{80}$) would be merely as 6 : 5.[2]

Whether the slight differences still apparent in the case of the stronger solutions are due to the formation of a sensible coating in less than $\frac{1}{100}$ second, cannot be absolutely decided; but the probability appears to lie in the negative. No distinct differences could be detected between the first and second wave-lengths; but this observation is, perhaps, not accurate enough to settle the question. It is possible that a coating may be formed on the surface of the glass and metal, and that this is afterwards carried forward.

[1] Although I can find no note of the fact, I think I am right in saying that large bubbles could be blown with the weakest of the solutions experimented upon.

[2] Curiously enough, I find it already recorded in my note-book of 1879, that λ is not influenced by the addition to water of soap sufficient to render impossible the rebound of colliding jets.

As a check upon the method, I thought it desirable to apply it to the comparison of pure water and dilute alcohol, choosing for the latter a mixture of 10 parts by volume of strong (not methylated) alcohol with 90 parts water. The results were as follows:—

$$2\lambda \text{ (water)} = 38\cdot5, \quad 2\lambda \text{ (alcohol)} = 46\cdot5,$$
$$h \text{ (water)} = 30\cdot0, \quad h \text{ (alcohol)} = 22\cdot0 ;$$

but it may be observed that they are not quite comparable with the preceding for various reasons, such as displacements of apparatus and changes of temperature. It is scarcely worth while to attempt an elaborate reduction of these numbers, taking into account the differences of specific gravity in the two cases; for, as was shown in the former paper, the observed values of λ are complicated by the departure of the vibrations from isochronism, when, as in the present experiments, the deviation from the circular section is moderately great. We have—

$$(46\cdot5/38\cdot5)^2 = 1\cdot46, \qquad 30/22 = 1\cdot36 ;$$

and these numbers prove, at any rate, that the method of wave-lengths is fully competent to show a change in tension, provided that the change really occurs at the first moment of the formation of the free surface.

In view of the great extensibility of saponine films it seemed important to make experiments upon this material also. The liquid employed was an infusion of horse chestnuts of specific gravity 1·02, and, doubtless, contained other ingredients as well as saponine. It was capable of giving large bubbles, even when considerably diluted (6 times) with water. Photographs taken on November 23 gave the following results:—

$$2\lambda \text{ (water)} = 39\cdot2, \quad 2\lambda \text{ (saponine)} = 39\cdot5,$$
$$h \text{ (water)} = 30\cdot5, \quad h \text{ (saponine)} = 20\cdot7.$$

Thus, although the capillary heights differ considerably, the tensions at the first moment are almost equal. In this case then, as in that of soap, there is strong evidence that the lowered tension is the result of the formation of a pellicle.

Though not immediately connected with the principal subject of this communication, it may be well here to record that I find saponine to have no effect inimical to the rebound after mutual collision of jets containing it. The same may be said of gelatine, whose solutions froth strongly. On the other hand, a very little soap or oleate usually renders such rebound impossible, but this effect appears to depend upon *undissolved* greasy matter. At least the drops from a nearly vertical fountain of *clear* solution of soap were found not to scatter (Roy. Soc. Proc., June 15, 1882). The rebound of *jets* is, however, a far more delicate test than that of *drops*. A fountain of strong saponine differs in appearance from one of water; but this effect is due rather to the superficial viscosity, which retards, or altogether prevents, the resolution into drops.

The failure of rebound when jets or drops containing milk or undissolved soap come into collision has not been fully explained; but it is probably connected with the disturbance which must arise when a particle of grease from the interior reaches the surface of one of the liquid masses.

P.S.—I have lately found that the high tension of recently formed surfaces of soapy water was deduced by A. Dupré ("Théorie Mécanique de la Chaleur," Paris, 1869), as long ago as 1869, from some experiments upon the vertical rise of fine jets. Although this method is less direct than that of the present paper, M. Dupré must be considered, I think, to have made out his case. It is remarkable that so interesting an observation should not have attracted more attention.

NOTES.

IT is stated that the committee to be appointed to inquire into colour-blindness in seamen, railway guards, and others, will not be exclusively confined to members of the Royal Society. Some gentlemen who, like Dr. Farquharson, M.P., and Mr. Bickerton, of Liverpool, have taken special interest in the question will, it is said, be asked to join the committee. A further question on the subject will, in the course of a few days, be put to the President of the Board of Trade.

WE regret to have to record the death of Sir John Henry Lefroy, F.R.S. He died on Friday evening last at his residence, Lewarne, a few miles from Liskeard. He was seventy-three years of age. He entered the Royal Artillery in 1834, and was Director of the Magnetical and Meteorological Observatory at St. Helena from 1840 to 1841, whence he moved to a similar position at Toronto in 1842. During the next year he made a magnetic survey of the interior of North America from Montreal to the Arctic Circle. From 1854 to 1855 he was scientific adviser to the Duke of Newcastle at the War Office on subjects of artillery and inventions, and in 1855 he was sent, as lieutenant-colonel, on a special mission to the seat of war. Afterwards he held several high military appointments. In 1882 he was made a general, and retired. He had been elected a Fellow of the Royal Society in 1848.

MR. THOMAS JOHNSON, Demonstrator in Botany at the Normal School of Science and Royal School of Mines, has been appointed to succeed the late Prof. McNab, as Professor of Botany at the Royal College of Science, Dublin. Prof. Johnson begins lecturing this term.

AN International Medical Congress was opened at Vienna on Tuesday, and will continue its sittings until to-morrow (Friday). Many physicians from the principal Europe an countries are taking part in the proceedings.

AT the next meeting of the Anthropological Institute, on Tuesday, April 22, M. Jacques Bertillon will give a lecture, with demonstrations, on the method now practised in France of identifying criminals by comparing their measures with those of convicted persons in the prison registers. The registers contain the measures of many tens of thousands of persons, with their photographs; yet M. Bertillon's method enables the reference to be rapidly effected. It is thought, therefore, that the authorities in England who are concerned with the police, or with the identification of deserters from the army or the navy, may be glad of the opportunity of hearing M. Bertillon's exposition.

THE Meteorological Office has adopted a new way of spreading information as to the condition of the weather on our coasts. On Monday it began to exhibit, at 63 Victoria Street, Westminster, outside the building, a series of boards, showing the state of the wind, weather, and sea at Yarmouth, Dover, the Needles, Scilly, Valentia (Ireland), and Holyhead. The information given is for 8 o'clock in the morning and 2 o'clock in the afternoon, and the notices are posted up at about 9.30 a.m. and 3 p.m. respectively. The words are printed in clear type, and can be read by those having ordinarily good sight from the pavement or roadway.

AT the meeting of the Institution of Civil Engineers on Tuesday evening, Sir Frederick Bramwell read a paper on the application of electricity to welding, stamping, and other cognate purposes.

THERE has been some talk lately about a scheme for the construction of a bridge across the Bosphorus. The Turkish newspaper *Hakikat* gives some particulars of the project *à propos* of an offer by a French syndicate to build a bridge of 800 metres in length and 70 metres high between Roumeli and Anatoli Hissar. The bridge would consist of one span, and this would exceed in length by one-half the longest span of the Forth Bridge. The Anatolian railway, it is thought, will make the construction of such a bridge a necessary and feasible undertaking before many years.

MADAME ROSA KIRSCHBAUM, who has taken the degree of Doctor of Medicine at a Swiss University, has been authorized by a special imperial decree to conduct a hospital for eye diseases at Salzburg. The Vienna Correspondent of the *Times* says this is the first case of a lady physician being admitted to medical practice in Austria.

THE new number of the *Kew Bulletin* begins with a section on canaigre, the root of which seems likely to take an important place as a tanning material. This is followed by sections on pistachio cultivation in Cyprus, Indian sugar, and mites on sugar-cane. The section on Indian sugar consists chiefly of a selection from a file of documents sent to Kew from the India Office, containing much valuable information as to the production of cane sugar in India.

AT the meeting of the Scientific Committee of the Royal Horticultural Society on April 8, Mr. Wilson exhibited a plant of a primrose, a seedling from Scott Wilson, showing a greater advance to a deep blue colour thanh as yet been made. A series of intermediate forms were also shown.

THE Prefect of Savoy has recently prohibited the gathering of the *Cyclamen* in the woods of his department. Notwithstanding its abundance in the locality, this beautiful plant had been threatened with total extinction, from the enormous numbers gathered each year for sale in the markets of Chambéry and Aix-les-Bains.

A SINGULAR fact is related by M. Lagatu in the *Feuille des Jeunes Naturalistes*. In the year 1884 a large number of cattle died after having browsed in a particular pasture in the department of l'Oise. M. E. Prillieux found the cause of death to be poisoning by ergotized *Lolium*; and he attributes it to the fact that the cattle were sent to the pasture about 10 days later than usual. M. Prillieux frequently found ergot on tufts of grass refused by the cattle, which marked the spots where dejecta had been left without being scattered.

DR. G. B. DE TONI has retired from the editorship of the Italian bi-monthly journal *Notarisia*, devoted to cryptogamic botany, which will in future be conducted by Dr. David Levi Morenos.

AT the last meeting of the Natural History Society of Kiel, Major Reinhold read a paper on the botanical condition of the German Ocean. According to researches recently made, the eastern part is almost wholly bare of vegetation. This is believed to be owing to the strong tidal currents, which so disturb the sea bottom as to prevent the germs and spores of marine plants from settling.

A ZOOLOGICAL floating station is now in working order at Isefiord on the Danish coast, under the direction of Dr. Petersen.

THE Proceedings of the International Congress of Zoology, held last August in Paris, were issued a few days ago. Among the contributors are Messrs. Bogdanow, Bowdler Sharpe, D'Arcy Thompson, E. P. Wright, C. V. Riley, V. Wagner, Ray Lankester, A. S. Packard, Trimen, Rütimeyer, Retzius, Hubrecht, de Selys-Longchamps, Agassiz, Blanford, L. Netto, W. A. Conklin, A. Fritsch, and McLachlan. This list of names suffices to show that the meeting was really of an international character.

A SHOCK of earthquake was felt in M U.S.A., on April 11.

REPORTS of an earthquake felt on March 26, between 9.15 and 9.20 p.m., have been received from Innsbruck, the Ziller Valley, Sterzing, Bozen, Meran, the Puster Valley, Salurn, Arco, Ampezzo, and the Weiten Valley. The direction of the shocks was from north to south.

TWO papers on "The Cradle of the Semites," read before the Philadelphia Oriental Club, have just been published. The first is by Dr. Daniel G. Brinton, who contends that the Semitic stock came originally from "those picturesque valleys of the Atlas which look forth toward the Great Ocean and the setting sun." Prof. Jastrow, the author of the second paper, agrees generally as to the probability of a Semitic migration from Africa into Asia, but thinks that Dr. Brinton goes farther than the evidence warrants when he tries to indicate the particular region of Africa from which the migration started.

DURING the summer and autumn of 1888, and the following winter, Mr. Albert Koebele carried on researches in Australia for the purpose of determining whether it would not be possible to introduce into California the most efficient of the Australian natural enemies of the fluted scale (*Icerya purchasi*, Maskell). A report on his investigations has just been issued by the U.S. Department of Agriculture; and from this it seems that the results achieved by him are highly satisfactory. Prof. Riley, who contributes an introduction to the report, says that one of the insects imported, the Cardinal Vedalia (*Vedalia cardinalis*, Mulsant), has multiplied and increased to such an extent as to rid many of the orange-groves of Icerya, and to promise immunity in the near future for the entire State of California.

SOME interesting notes on the archæology and ethnology of Easter Island, by Mr. Walter Hough, appear in the new number of the *American Naturalist*. One of the last acts of the late Prof. Spencer F. Baird was to induce the American Navy Department to send a vessel to explore the island and bring back representative specimens. The U.S.S. *Mohican*, then at Tahiti, was detailed, and the fruits of the successful twelve days' exploration are now to be seen in the north and west halls of the American National Museum. They consist of several stone images, carved stones, painted slabs, and a fine collection of smaller objects obtained by Paymaster W. J. Thomson, U.S.N. In his article Mr. Hough makes good use of the materials thus brought together, and of information placed at the disposal of the National Museum by Mr. Thomson, and by Surgeon G. H. Cooke, U.S.N.

TWO interesting papers on primitive architecture, by Mr. Barr Ferree, have been reprinted together, one from the *American Naturalist*, the other from the *American Anthropologist*. In the first article the author deals with sociological influences, in the second with climatic influences.

FROM the reports, for the past official year, of the Directors of Public Instruction and their subordinates in various Indian districts, on vernacular literature, it appears that, on the whole, but very little scientific work of an original character is being performed by natives of India, and that the taste for scientific literature, original or translated, can scarcely be said to exist. In Bengal, the Director says that, "while physiology keeps in old grooves, medicine seems to be trying to return to them." In Madras scientific works appear to have been confined to the translation of an old Sanskrit work on medicine, unless indeed "a collection of a thousand stanzas in Tamil verse, treating of the Yoga philosophy, can be called scientific." In the North-West Provinces eleven works on medicine were registered during the year, some of them being translations, while others are described as original works of some merit. The great mass of Indian literature appears to be composed of fiction, poetry, and the drama, and, in Bengal especially, is described as for the most part worthless and immoral.

It is well known that a connection has been observed (in Munich and other towns) between ground-water and typhus; the disease gaining force as the water goes down, and declining as the water rises. (It is thought that certain decompositions are favoured by air taking the place of water in the ground.) While in former years Hamburg has exemplified this effect, the last typhus epidemic there, according to Prof. Brückner, was quite in discordance with the variations of ground-water. From 1838, it is stated, the typhus mortality in Hamburg steadily fell from 19 to 2 or 3 per 1000; but from 1885 it rose again to 9; and whereas before 1885 the epidemic was a summer one, with its maximum in August, it now became a winter one, with maximum in December. The curve of ground-water continued to have the same course as before. Prof. Brückner points out that this epidemic of 1884–87 corresponded in time with certain harbour works being carried out at Hamburg, and he attributes it to the upturning of enormous masses of earth, the abode of numberless bacteria, whose diffusion among the inhabitants was thus facilitated.

The volume of Results of the Magnetical and Meteorological Observations made at the Royal Observatory, Greenwich, in the year 1887, contains an appendix of considerable importance to meteorologists, viz. the hourly reduction of the photographic records of the barometer for 1874–76, and of the dry and wet bulb thermometers for 1869–76. This appendix, which is also published separately, continues the results for the twenty years published in 1878. The tables now given complete the reduction of the photographic records nearly to the present time, commencing with the year 1854 for the barometer, and with the year 1849 for the thermometers. The means for the two periods are given separately, but their value would be further enhanced if the results for the whole period were also given in a combined form.

With the month of January, the Monthly Weather Review of the United States Signal Service entered upon its eighteenth year of publication. The Review is based upon reports from 1934 observers, a large majority of whom belong to the State Weather Services. This number is exclusive of the reports which are usually supplied by the Central Pacific Railway Company, but which could not be forwarded for January, owing to snow blockades and floods. One hundred and twenty miles of the railroad crossing the Sierra Nevada range of mountains was blockaded by snow, being the heaviest blockade ever known there, and it is estimated that fully 50 per cent. of the live stock was lost from exposure and starvation. The paths of twelve depressions that appeared over the North Atlantic Ocean are plotted on a chart. Of the nine depressions that moved eastwards from the American continent, four were traced to the British Isles. Three storms first appeared over the ocean, and two of these were also traced to the British Isles. Among the "Notes and Extracts" is an article on the recent comparison of anemometers, by Prof. Marvin. The results obtained show that of the anemometers exposed to the same wind, those with short arms gave a lower velocity than those with long arms. No experiments were made beyond 32 miles per hour, and although various formulæ were given for the reduction of wind velocities, Prof. Marvin states that they cannot be depended on for velocities beyond the experimental values, so that much more information has yet to be gained, as to the action of anemometers with high velocities, from careful experiments with whirling machines. We take this opportunity of pointing out that a general subject-index to the Monthly Weather Reviews and the Annual Reports of the Chief Signal Officer, to 1887, has been published, and affords easy reference to the valuable information contained in these publications.

A recent writer in the *North China Herald* of Shanghai says that the climate of Asia is becoming colder than it formerly was, and its tropical animals and plants are retreating southwards at a slow rate. This is true of China, and it is also the case in Western Asia. The elephant in a wild state was hunted in the eighth century B.C. by Tiglath Pileser, the King of Assyria, near Carchemish, which lay near the Euphrates in Syria. Four or five centuries before this Thothmes III., King of Egypt, hunted the same animal near Aleppo. In high antiquity the elephant and rhinoceros were known to the Chinese, they had names for them, and their tusks and horns were valued. South China has a very warm climate which melts insensibly into that of Cochin-China, so that the animals of the Indo-Chinese peninsula would, if there were a secular cooling of climate, retreat gradually to the south. This is just what seems to have taken place. In the time of Confucius elephants were in use for the army on the Yangtze River. A hundred and fifty years after this, Mencius speaks of the tiger, the leopard, the rhinoceros, and the elephant, as having been, in many parts of the empire, driven away from the neighbourhood of the Chinese inhabitants by the founders of the Chou dynasty. Tigers and leopards are not yet by any means extinct in China. The elephant and rhinoceros are again spoken of in the first century of our era. If to these particulars regarding elephants be added the retreat from the rivers of South China of the ferocious alligators that formerly infested them, the change in the fauna of China certainly seems to show that the climate is much less favourable for tropical animals than it formerly was. In fact it appears to have become drier and colder. The water buffalo still lives, and is an extremely useful domestic animal, all along the Yangtze and south of it, but is not seen north of the old Yellow River in the province of Kiangsu. The Chinese alligator is still found in the Yangtze, but so rare is its appearance that foreign residents in China knew nothing about it till it was described by M. Fauvel. The flora is also affected by the increasing coldness of the climate in China. The bamboo is still grown in Peking with the aid of good shelter, moisture, and favourable soil, but it is not found naturally growing into forest in North China, as was its habit two thousand years ago. It grows now in that part of the empire as a sort o garden plant only. It is in Szechuan province that the southern flora reaches farthest to the northward.

Some interesting experiments on the physiology of sponges have been recently made by Dr. Lendenfeld, of Innsbruck (*Humboldt*). He operated with eighteen different species, putting carmine, starch, or milk, in the water of the aquarium, and also trying the effect of various poisons—morphine, strychnine, &c. The following are some of his results: Absorption of food does not take place at the outer surface, but in the interior; only foreign substances used for building up the skeleton enter the sponge without passing into the canal-system. Grains of carmine and other matters often adhere to the flat cells of the canals, but true absorption only takes place in the ciliated cylindrical cells of the ciliated chamber. These get quite filled with carmine grains or milk spherules, but starch grains prove too large for them. Remaining in these cells a few days, the carmine cells are then ejected; while milk particles are partly digested, and then passed on to the migratory cells of the intermediate layer. Any carmine particles found in these latter cells have entered accidentally through external lesions. The sponge contracts its pores when poisons are put in the water; and the action is very like that of poisons on muscles of the higher animals. Especially remarkable is the cramp of sponges under strychnine; and the lethargy (to other stimuli) of sponges treated with cocain. As these poisons, in the higher animals, act indirectly on the muscles through the nerves, it seems not without warrant to suppose that sponges also have nerve-cells which cause muscular contraction.

THE additions to the Zoological Society's Gardens during the past week include a Black-eared Marmoset (*Hapale penicillata*) from South-east Brazil, presented by Mr. J. A. Watson, F.Z.S ; a Lesser White-nosed Monkey (*Cercopithecus petaurista* ♀) from West Africa, presented by Mr. E. B. Parfitt ; a Macaque Monkey (*Macacus cynomolgus* ♀) from India, presented by Mrs. H. F. Batt ; a Sambur Deer (*Cervus aristotelis* ♂) from India, presented by Capt. George James ; a Common Badger (*Meles taxus*, white variety), British, presented by the Hon. Morton North ; a Jackdaw (*Corvus monedula*), British, presented by Mrs. Bowden ; a Blessbok (*Alcelaphus albifrons* ♂) from South Africa, four Undulated Grass Parrakeets (*Melopsittacus undulatus* 2 ♂ 2 ♀) from Australia, deposited ; an Australian Crane (*Grus australasiana*), two Chestnut-eared Finches (*Amadina castanotis*) from Australia, three European Flamingoes (*Phœnicopterus antiquorum*), four Great Bustards (*Otis tarda*), European, purchased.

OUR ASTRONOMICAL COLUMN.

OBJECTS FOR THE SPECTROSCOPE.

Sidereal Time at Greenwich at 10 p.m. on April 17 = 11h. 43m. 55s.

Name.	Mag.	Colour.	R.A. 1890.	Decl. 1890.
			h. m. s.	° ′
(1) G.C. 2841	—	White.	12 13 33	+47 55
(2) 137 Schj.	6	Yellowish-red.	10 54 5	−15 52
(3) φ Leonis...	4	Yellowish-white.	11 11 6	− 3 3
(4) β Leonis	2	White.	11 43 30	+15 11
(5) 155*b* Schj.	7	Red.	12 52 6	+66 35
(6) U Virginis	Var.	Reddish.	12 45 31	− 6 9

Remarks.

(1) This large white nebula is situated in the constellation of Ursa Major, and is thus described in the General Catalogue :—"Very bright, very large, suddenly brighter in the middle to a nucleus." According to Smyth, it is oval in shape, the lateral edges being better defined than the ends. Lord Rosse's telescope s' owed it to be much mottled. In 1866 Dr. Huggins described its spectrum as continuous, with "a suspicion of unusual brightness about the middle part." No observations of the spectrum appear to have been made since then, but it is important that it should be re-examined. The spectra of the white nebulæ are usually almost entirely wanting in red light, and it is therefore quite possible that the brightening in the middle is nothing more than the green carbon fluting near λ517. Direct comparisons with the spectrum of a spirit-lamp flame would soon decide this point. In any case, if there be one or more brightenings, some attempt should be made to determine their positions.

(2) The spectrum of this star has not yet been completely described. Secchi stated that it was of the type of α Orionis, and Dunér states that it is most probably a star of Group II., but very feebly developed. As I have previously pointed out, it is these "feebly developed" stars of Group II. which require further examination rather than those which are described as "fully developed," as they are probably transition stages between Groups I. and II., or Groups II. and III.

(3) According to Konkoly, this star has a well-developed spectrum of the solar type. Differential observations as to whether the star belongs to Group III. or to Group V. are required. (For criteria so far determined, see p. 20.)

(4) The spectrum of this star is a very fine one of Group IV. The usual observations are required.

(5) D'Arrest and Dunér both describe the spectrum of this star as a magnificent one of Group VI. According to Dunér, the principal bands are very dark, and the subsidiary bands 4 and 5 are well visible, while the bands 1, 2, 3 are very weak. He also states that the spectrum is rendered unique by the fact that the least refrangible part of the sub-zone in the yellow is considerably weaker than the other. Further observations, as previously suggested for similar stars, should be made.

(6) This star affords another opportunity of searching for bright lines in the spectrum of a variable of Group II. near maximum. Vogel states that the spectrum is a fine one of Group II., but we have as yet no detailed description of the bands present. The period of the variable is about 207 days, and it ranges in magnitude from 7·7–8·1 at maximum to 12·2–12·8 at minimum. The maximum will occur on April 21, but as Mr. Espin has noticed that the bright lines sometimes do not appear until after the maximum, it will be desirable to continue the observations for some days after. The variations of the bright carbon flutings should also receive attention.

A. FOWLER.

COMET BROOKS (*a* 1890).—The following elements have been computed by Dr. Bidschof, of the Imperial Observatory, Vienna, from observations at Cambridge, U.S., March 21 ; Vienna, March 4 and 28 (*Astr. Nach.*, No. 2962):—

T = 1890 June 3·6399 Berlin mean time.

$$\left.\begin{aligned}\omega &= 71^\circ\ 7'\!\cdot\!5\\ \Omega &= 320\ 44\!\cdot\!9\\ \iota &= 121\ 17\!\cdot\!2\end{aligned}\right\}\text{ Mean Eq. 1890·0.}$$

$$\log q = 0\cdot27189$$

Ephemeris for Berlin Midnight.

1890.	R.A.	Decl.	1890.	R.A.	Decl.
	h. m. s.	° ′		h. m. s.	° ′
April 16...21	9 21...	+19 21·0	April 26...21	4 5...	+26 15·1
17...	9 0...	19 59·2	27...	3 18...	27 0·9
18...	8 37...	20 38·0	28...	2 27...	27 47·6
19...	8 13...	21 17·5	29...	1 33...	28 35·0
20 ..	7 47...	21 57·7	30...	0 34...	29 33·3
21...	7 18...	22 38·6	May 1...20	59 31...	30 12·4
22...	6 46...	23 20·3	2...	58 23...	31 2·3
23...	6 10...	24 2·8	3...	57 10...	31 52·9
24...	5 32...	24 46·1	4...	55 51...	32 44·3
25...	4 50...	25 30·2			

Brightness, that at discovery being unity—

18 April = 1·81.	30 April = 2·39.
22 ,, = 1·99.	4 May = 2·62.
26 ,, = 2·18.	

NEW VARIABLE IN CÆLUM.—Prof. Pickering, in a communication to *Astr. Nach.*, No. 2962, notes that an examination of a plate taken by Mr. S. J. Bailey at the Closica station in Peru, shows that the G and *h* lines of hydrogen are bright in the spectrum of a star whose position for 1875 is R.A. 4h. 36·2m., Decl. − 38° 29′. An inspection of photographic chart plates indicates that the star is variable, and its spectrum seems to place it in the same class as *o* Ceti, R Hydrae, R Leonis, and other long-period variables. The date on which the plate was taken is not given, but it is observed that the spectrum is as bright photographically as that of Cordoba Catalogue No. 1077, which is of the magnitude 7½, and since the former is a red star, it was probably much brighter visually. Eye observations at Cambridge, U.S., on February 20 and 21 of this year show that the star was then about magnitude 10·5. It seems, therefore, that the bright lines of hydrogen were photographed in the spectrum of this object when it was near a maximum.

GEOGRAPHICAL NOTES.

THE Council of the Royal Geographical Society met on Monday, and finally decided upon the awards of the honours for the year. One of the Royal Medals has been awarded to Emin Pasha, in recognition of the services rendered by him to geography and the allied sciences by his explorations and researches in the countries east, west, and south of the Upper Nile during his administration of the Equatorial Province of Egypt. The other Royal Medal has been awarded to Lieut. F. E. Younghusband, for his journey across Central Asia in 1886–87, from Manchuria and Pekin *viâ* Hami and Kashgar, and over the Mushtagh to Cashmere and India, a distance of 7000 miles. The Cuthbert Peek grant has been awarded to Mr. E. C. Hare for his observations on the physical geography of Tanganyika made during his many years' residence on that lake. The Murchison grant has been awarded to Signor Vittoria Sella, in consideration of his recent journey in the Caucasus, and the advance made in our knowledge of the physical characteristics and the topography of the chain by means of his series of panoramic photographs taken above the snow level. The G ill memorial has been given to Mr. C. M. Woodford, for his three expeditions to the Solomon Islands, and the additions made by him to our topographical knowledge and the natural history of the islands. The new honorary corresponding members are Prof. Davidson, of San Francisco; Dr. Junker, the friend of Emin Pasha, and Central African explorer; and Senhor Santa Anna Nery, of Rio Janeiro.

AT the evening meeting of the Royal Geographical Society on Monday, Sir M. E. Grant Duff in the chair, Dr. Hans Meyer read a paper on his journey to the summit of Kilima-Njaro. After giving a short account of his expedition in 1887, and the discouragements to which he had been subjected on two subsequent efforts to carry out his programme, Dr. Meyer proceeded to say that, while the main portion of the caravan encamped in Marangu, he ascended with Herr Purtscheller and eight picked men through the primæval forest to a stream beyond, where he had encamped in the year 1887, at an altitude of 9200 feet. There their large tent was pitched, straw huts were built for the men, and firewood collected. Accompanied by four men they travelled for two more days up the broad, grassy, southern slopes of Kilima-Njaro to the fields of rapilli on the plateau between Kibo and Mawenzi, and found there to the south-east of Kibo, under the protection fforded by some blocks of lava, a spot, at an altitude of 14,270 feet, well suited for the erection of their small tent. As soon as the instruments and apparatus had been placed under cover, three of the men returned to the camp on the edge of the forest, and only one, a Pangani negro, Mwini Amani by name, remained to share, uncomplainingly, their sixteen days' sojourn on the cold and barren heights. With regard to their maintenance, it had been arranged that every third day four men should come up with provisions from the lower camp in Marangu to the central station on the edge of the forest, and that two of the men stationed there should thence convey the necessary food to them in the upper camp, returning immediately afterwards to their respective starting-places. And this accordingly was done. Firewood was supplied by the roots of the low bushes still growing there in a few localities, and their negro fetched a daily supply of water from a spring rising below the camp. In that manner they were enabled, as if from an Alpine Club hut, to carry out a settled programme in the ascent and surveying of the upper heights of Kilima-Njaro. The ice-crowned Kibo towered up steeply another 5000 feet to the west of their camp, itself at an altitude of 14,300 feet. On October 3 they undertook their first ascent. The previous day they had resolved to make the first attempt, not in the direction chosen by him in 1887, but up a large rib of lava which jutted out to the south-east, and formed the southern boundary of the deepest of the eroded ravines on that side of the mountain. Their simple plan of operations, which they succeeded in carrying out, was to climb up this lava-ridge to the snow-line, to begin from its uppermost tongue the scramble over the mantle of ice, and endeavour to reach by the shortest way the peak to the south of the mountain, which appeared to be the highest point. It was not till half-past 7 o'clock that they reached the crown of that rib of lava which had been their goal from the very first, and, panting for breath, they began to pick their way over the boulders and *débris* covering the steep incline of the ridge. Every ten minutes they had to pause for a few moments to give their lungs and beating hearts a short breathing space, for they had now for some time been above the height of Mont Blanc, and the increasing rarefaction of the atmosphere was making itself gradually felt. At an altitude of 17,220 feet they rested for half an hour; apparently they had attained an elevation superior to the highest point of Mawenzi, which the rays of the morning sun were painting a ruddy brown. Below them, like so many mole-heaps, lay the hillocks rising from the middle of the saddle. A few roseate cumulus clouds floated far over the plain, reflecting the reddish-brown laterite soil of the steppe; the lowlands, however, were but dimly visible through the haze of rising vapour. The ice-cap of Kibo was gleaming above their heads, appearing to be almost within reach. Shortly before 10 o'clock they stood at its base, at an elevation of 18,270 feet above sea-level. At that point the face of the ice did not ascend, but almost immediately afterwards it rose at an angle of 35°, so that, without ice-axes, it would have been absolutely impracticable. The toilsome work of cutting steps in the ice began about half-past 10; slowly they progressed by the aid of the Alpine rope, the brittle and slippery ice necessitating every precaution. They made their way across the crevices of one of the glaciers that projected downwards into the valley which they had traversed in the early morning, and took a rest under the shadow of an extremely steep protuberance of the ice-wall at an altitude of 19,000 feet. On recommencing the ascent the difficulty of breathing became so pronounced that every fifty paces they had to halt for a few seconds, bending their bodies forward and gasping for breath. The oxygen of the air amounted there, at an elevation of 19,000 feet, to only 40 per cent., and the humidity to 15 per cent. of what it was at sea level. No wonder that their lungs had such hard work to do. The surface of the ice became increasingly corroded; more and more it took the form which Güssfeldt, speaking of Aconcagua, in Chili, called *nieve penitente*. Honeycombed to a depth of over 6 feet, in the form of rills, teeth, fissures, and pinnacles, the ice-field presented the foot of the mountaineer with difficulties akin to that of a "Karrenfeld." They frequently broke through as far as their breasts, causing their strength to diminish with alarming rapidity. And still the highest ridge of ice appeared to be as distant as ever. At last, about 2 o'clock, after eleven hours' climb, they drew near the summit of the ridge. A few more hasty steps in the most eager anticipation, and then the secret of Kibo lay unveiled before them. Taking in the whole of Upper Kibo, the precipitous walls of a gigantic crater yawned beneath them. The first glance told that the most lofty elevation of Kibo lay to their left, on the southern brim of the crater, and consisted of three pinnacles of rock rising a few feet above the southern slopes of the mantle of ice. They first reached the summit on October 6, after passing the night below the limits of the ice, in a spot sheltered by overhanging rocks, at an altitude of 15,160 feet, an elevation corresponding to that of the summit of Monte Rosa. Wrapped up in their skin bags, they sustained with tolerable comfort even the minimum temperature of 12° F., experienced during the night, and were enabled, about 3 o'clock in the morning of October 6, to start with fresh energy on their difficult enterprise of climbing the summit; and this time Njaro, the spirit of the ice-crowned mountain, was gracious to them—they reached their goal. At a quarter to 9 they were already standing on the upper edge of the crater, at the spot from which they had retraced their steps on October 3. Their further progress, from this point to the southern brim of the crater, although not easy, did not present any extraordinary difficulty. An hour and a half's further ascent brought them to the foot of the three highest pinnacles, which they calmly and systematically climbed one after another. Although the state of the atmosphere and the physical strain of exertion remained the same as on the previous ascent, yet this time they felt far less exhausted, because their condition morally was so much more favourable. The central pinnacle reached a height of about 19,700 feet, overtopping the others by 50 to 60 feet. He was the first to tread, at half-past 10 in the morning, the culminating peak. He planted a small German flag, which he had brought with him in his knapsack, upon the rugged lava summit, and christened that—the loftiest spot in Africa—Kaiser Wilhelm's Peak. After having completed the necessary measurements, they were free to devote their attention to the crater of Kibo, of which an especially fine view was obtainable from Kaiser Wilhelm's Peak. The diameter of the crater measured about 6500 feet, and it sank down some 600 feet in depth. In the southern portion the walls of lava were either of an ash-grey or reddish-brown colour, and were entirely free from ice, descending almost perpendicularly to the base of the crater; and in its northern half the ice sloped downwards from the upper brim of the crater in terraces, forming blue and white galleries of varying steepness. A rounded cone of eruption, composed of brown ashes and lava, rose in the northern portion of the crater to a height of about 500 feet, which was partly covered by the more than usually thick sheet of ice extending from the northern brim of the crater. The large crater opened westwards in a wide cleft, through which the melting water ran off, and the ice lying upon the western part of the crater and the inner walls issued in the form of a glacier. What a wonderful contrast between this icy stream and the former fiery incandescence of its bed! And above all this there reigned the absolute silence of inanimate nature, forming in its majestic simplicity a scene of the most impressive grandeur. An indelible impression was created in the mind of the traveller to whom it had once been granted to gaze upon a scene like that, and all the more when no human eye had previously beheld it. And certainly as they sat that evening in their little tent, which they finally reached at nightfall, after a most arduous return march through the driving mist, and carried their thoughts back to the expeditions of 1887 and 1888, they would indeed have changed places with no one. After giving further details of the expedition, the lecturer said that on October 30 they sorrowfully bade farewell to Kilima-Njaro, the most beautiful and interesting, as well as the grandest, region in the dark continent. At the conclusion of the paper a series of photographs illustrative of some features of the expedition was exhibited by lime-light, and explained by Mr. Ravenstein. A vote of thanks to Dr. Meyer was proposed by Mr. Joseph Thomson, seconded by Mr. Douglas Freshfield, and heartily accorded.

A NEW GREEN VEGETABLE COLOURING MATTER.[1]

THE seeds of the *Trichosanthes palmata* are inclosed in a rounded scarlet fruit and embedded in a green bitter pulp. The bitter principle has been shown by Mr. D. Hooper to be a glucoside differing from colocynthin, and he has named it trichosanthin. The green colouring matter, when freed from the trichosanthin and fatty matter, yields a solution closely resembling a solution of cholorophyll. It is green in thin and red in thick layers, and has a red fluorescence. The spectrum, however, is very different. Taking the thickness and strength yielding the most characteristic spectrum, it may be described thus:—The first band begins (penumbra) at W.L. 654 and ends about W.L. 615; from this there is a small amount of absorption till the second band begins at W.L. 593·4, and continues to W.L. 566·8, with the maximum absorption near the less refrangible end; from this there is no perceptible absorption till the third band, which extends from W.L. 548·4 to 534·8; there is a fourth band, very faint, with its centre about W.L. 510·6, and a fifth extending from about W.L. 485 to W.L. 473·4. Comparing this with the chlorophyll spectrum, it will be seen that the first band has its centre almost midway between the two chief chlorophyll bands, but that bands III., IV., and V. are probably coincident with chlorophyll bands. When the trichosanthes colouring matter is treated with ammonia sulphide the spectrum is completely changed. The first and most prominent band slowly decreases in strength and finally disappears, two new bands appear in the space between bands I. and II. of the original spectrum; band II. is apparently displaced towards the violet end and intensified; and band IV. is greatly widened. Chlorophyll under the same treatment behaves in a totally different manner, and the two spectra become almost complementary. When, however, the trichosanthes colouring matter and chlorophyll are both treated with hydrochloric acid the result is very different, for the two spectra have now three bands in common. The first band in the trichosanthes spectrum has disappeared, and the spectrum is practically reduced to one of three bands corresponding in position with bands II., III., and IV. of the altered chlorophyll spectrum. Band I. of the chlorophyll spectrum has no representative in the trichosanthes spectrum. The conclusions to be derived from a study of these spectra seem to be that we have in the trichosanthes colouring matter a substance in which the "blue chlorophyll" of Sorby or the "green chlorophyll" of Stokes is replaced by some other substance easily decomposed by reducing agents and acids. Farther, if we assume with Schunck that the product obtained by acting on chlorophyll with hydrochloric acid is the same as Frémy's phyllocyanin, this, too, must be a mixture, one constituent of which is obtained by acting on the trichosanthes colouring matter with acid, while the other is, apparently, the unaltered substance yielding band I. in the chlorophyll spectrum.

SOCIETIES AND ACADEMIES

LONDON.

Royal Society, March 13.—"On the Organization of the Fossil Plants of the Coal-measures. Part XVII." By William Crawford Williamson, LL.D., F.R.S., Professor of Botany in the Owens College, Manchester.

In 1873 the author described in the Phil. Trans. an interesting stem of a plant from the Lower Carboniferous beds of Lancashire, under the name of *Lyginodendron Oldhamium*. He also called attention to some petioles of ferns, more fully described in 1874, under the name of *Rachiopteris aspera*. The former of these plants possessed a highly organized, exogenously developed xylem zone, whilst the *Rachiopteris* was only supplied with what looked like closed bundles. Since the dates referred to, a large amount of additional information has been obtained respecting both these plants. Structures, either not seen, or at least ill-preserved, have now been discovered, throwing fresh light on their affinities; but most important of all is the proof that the *Rachiopteris aspera* is now completely identified as the foliar rachis or petiole of the *Lyginodendron*: hence there is no longer room for doubting that, notwithstanding its indisputable possession of an exogenous vascular zone, the bundles of which exhibit both xylem and phloëm elements along with medullary and phloëm rays, it has been a true Fern. Though such exogenous developments have now been long known to exist amongst the Calamitean and Lycopodiaceous stems, as well as in other plants of the Carboniferous strata, we have had no evidence until now that the same mode of growth ever occurred amongst the Ferns. Now, however, this Cryptogamic family is shown to be no longer an exceptional one in this respect. All the three great divisions of the Vascular Cryptogams—the Equisetaceæ, the Lycopodiaceæ, and the Homosporous Filices of the primæval world—exhibited the mode of growth which is confined, at the present day, to the Angiospermous plants. A further interesting feature of the life of this *Lyginodendron* is seen in the history of the development of its conspicuous medulla. In several of his previous memoirs, notably in his Part IV., the author has demonstrated a peculiarity in the origin of the medulla of the Sigillarian and Lepidodendroid plants. Instead of being a conspicuous structure in the youngest state of the stems and branches of these plants, as it is in the recent Ferns, and as in most of the living Angiosperms, few or no traces of it are observable in these fossil Lycopodiaceæ. In them it develops itself in the interior of an apparently solid bundle of tracheæ (within which doubtless some obscure cellular germs must be hidden), but ultimately it becomes a large and conspicuous organ. The author has now ascertained that a similar medulla is developed, in precisely the same way, within a large vascular bundle occupying the centre of the very young twigs of the *Lyginodendron*. But in this latter plant other phenomena associated with this development make its history even yet more clear and indisputable than in the case of the Lycopods. The entire history of these anomalous developments adds a new chapter to our records of the physiology of the vegetable kingdom.

Further light is also thrown upon the structure of the *Heterangium Grievii*, originally described in the author's memoir, Part IV. This plant presents many features in its structure suggesting that it too will ultimately prove to be a Fern. The specimens described in the above memoir, published in 1873, all possessed a more or less developed exogenous xylem zone. But the author has now obtained other, apparently younger examples in which no such zone exists.

He has discovered the stem of a genus of plants (*Bowmanites*), hitherto known only by some fruits, the detailed organization of which was originally described by him in the Transactions of the Literary and Philosophical Society of Manchester, in 1871. The structure of this new stem corresponds closely with what is seen in *Sphenophyllum* and in some forms of *Asterophyllites* (Memoir V., Phil. Trans., 1874, p. 41, *et seq.*). This discovery makes an addition to our knowledge of the great Calamarian family, to which the plant obviously belongs.

Further demonstrations are also given by the author, illustrating some features in the history of the true Calamites. Attention is called to the fact that, whilst the large, longitudinally-grooved and furrowed inorganic casts of the central medullary cavities of these plants are extremely common, we never find similar casts of the smaller branches. The cause of this is demonstrated in the memoir. In these young twigs the centre of the branch is at first occupied by a parenchymatous medulla. The centre of this medulla becomes absorbed at a very early age, leaving the beginnings of a small fistular cavity in its place; but, if any plastic mud or sand entered this cavity when the plant was submerged, the surface of such a cast would exhibit no longitudinal groovings, because there would be nothing in the remaining medullary cells surrounding the cast to produce such an effect. It was only when the further growth of the branch was accompanied by a more complete absorption of the remaining medullary cells, causing the cavity thus produced to

[1] Abstracted from a paper by C. Michie Smith, "On the Absorption Spectra of Certain Vegetable Colouring Matters," read before the Royal Society of Edinburgh, March 17, 1890, and communicated by permission of the Council.

be bounded by the inner wedge-shaped angles of the longitudinal vascular bundles constituting the xylem zone, that such an effect could be produced. After that change any inorganic substance finding its way into the interior of this cavity had its surface so moulded by the wedges as to produce the superficial ridges and furrows so characteristic of these inorganic casts.

March 27.—"The Rupture of Steel by Longitudinal Stress." By Chas. A. Carus-Wilson. Communicated by Prof. G. H. Darwin, F.R.S.

This paper gives an account of experiments made with a view to determining the nature of the resistance that has to be overcome in order to produce rupture in a steel bar by longitudinal stress.

The stress required to produce rupture is in every case computed by dividing the load on the specimen at the moment of breaking by the contracted area at the fracture measured after rupture; this stress is called the "true tensile strength" of the material.

It is well known that any want of uniformity in the distribution of the stress over the ruptured section causes the bar to break at a lower stress than it would if the stress was uniformly distributed. Hence anything that causes want of uniformity is prejudicial; for instance, a groove turned in a cylindrical steel bar will produce want of uniformity, and will consequently be prejudicial, the stress at rupture being lower according as the angle of the groove is more acute. The most favourable condition of test might appear to be that in which a bar of uniform section throughout its length was allowed to draw out freely before breaking, since in this case the stress must be most uniformly distributed.

Experiment, however, shows that the plain bar is not always the strongest. So long as the want of uniformity of stress is considerable, owing to the groove being cut with a very sharp angle, the plain bar is stronger than the grooved bar; but, if the groove be semicircular instead of angular, the grooved bar is considerably stronger than the plain, in spite of the fact that the stress is more uniformly distributed in the latter.

It would seem, then, that we can strengthen a bar over any given section by adding material above and below it, the change in section being gradual; but such an addition of material cannot strengthen the bar if rupture is caused by a certain intensity of tensile stress over the ruptured section; the added material cannot increase the resistance of the ruptured section to direct tensile stress, but it can increase the resistance to the shearing stress.

The resistance of a given section of a steel bar does not, then, depend on its section at right angles to the axis, but on its section at 45° to the axis, for in that direction the shearing stress is a maximum. From this it would seem that the resistance overcome at rupture is the resistance of the steel to shear.

Experiments were made to see whether the resistance of steel to direct shearing bore to its resistance to direct tension the ratio required by the above theory; since the greatest shearing stress is equal to one-half the longitudinal stress, we should expect to find the resistance to direct shearing equal to one-half of the resistance to direct tension.

A series of experiments were made, with the result that the ultimate resistance to direct shearing was within, on the average, 3 per cent. of the half of that to direct tension.

The appearance of the fracture of steel bars is next discussed. It would appear that when the stress is uniformly disturbed in the neighbourhood of the ruptured section, the fracture is at 45° to the axis, the bar having sheared along that plane which is a plane of least resistance to shear. The tendency to rupture along a plane of shear may be masked by a non-uniform distribution of stress.

Two plates of photographs are added, showing examples of steel bars broken by shearing under longitudinal stress.

Physical Society, March 21.—Prof. W. E. Aryton, F.R.S., President, in the chair.—The following communications were read:—The Villari critical points in nickel and iron, by Herbert Tomlinson, F.R.S. Villari has shown that the permeability of iron is increased by longitudinal traction provided the magnetizing force does not exceed a certain limit, but beyond this limit traction produces a decrease of permeability. The value of the force for which traction produces no change in the permeability is known as the Villari critical point. As far as the author is aware, no previous observer has found a similar critical point for nickel, but by confining his attention to *temporary* magnetization he has detected such a point with comparative ease. He has also examined the variation of the Villari critical points in iron and nickel with change of load, and has investigated the influence of permanent strain on these points. The experiments were made by the ballistic method, using wires about 400 diameters long. In each set of observations the permeability was obtained with various loads, the magnetizing force being kept the same, and with each load the circuit was closed and opened until the swings on make and break were equal; this swing was taken as a measure of the induction under the given load. Several diagrams accompany the paper, in which load and percentage change of permeability are plotted, regard being had to sign. The author finds that for annealed unstrained iron the critical value of the force decreases as the load increases, and that the Villari point is much lower for *temporary* than for *total* magnetization. With a load of 4·7 kilos on a 1 mm. wire, the value of the force giving the temporary point was 2·8 C.G.S. units. He also found that for a given magnetizing force there are generally two loads which have no effect on the temporary magnetization. With unstrained nickel the critical value of the force is much greater than in iron, being about 114 C.G.S. units for a load of 10 kilos on a wire 0·8 mm. diameter, and 67 for a load of 6·6 kilos. For a force of 21 units no critical point exists. Experiments on a permanently strained iron wire show that for magnetizing forces ranging from 0·03 to 0·3 there is no critical point, and all the resulting curves are identical. There is, however, considerable difference in the observations taken during loading and those taken on unloading. For greater magnetizing forces the curves cease to be identical, and the maximum increase of permeability becomes less and less until for a certain force the curves begin to cut the load line. As the force increases beyond this value the point of cutting approaches the origin, and the curves begin to cut the load line in two points. Further increase of force to 3 C.G.S. units causes the first point to disappear, and the second point recedes from the origin. Finally, with sufficiently high magnetizing forces the second point cannot be reached before the wire breaks, and the curve lies entirely below the load line. With nickel the curves for very minute forces, like those of iron, are exactly the same for different values of the force, but they lie below the load line, *i.e.* the permeability is diminished by loading; there is no difference, however, in the loading and unloading curves. Beyond a certain value of the force the identity of the curves ceases, and that part of the curve near the origin bulges towards the load line. For a force a little over 21 C.G.S. units the permeability begins to increase with load, and the curve cuts the line in one point, which point recedes from the origin as the force increases. Mr. Shelford Bidwell said that Prof. J. J. Thomson, reasoning from the change of length by magnetization, had predicted a Villari point in cobalt when compressed, and this was verified experimentally. On applying similar reasoning to nickel he, (the speaker) did not expect to find a Villari point, and both Sir William Thomson and Prof. Ewing had searched in vain for one. In some experiments, not yet completed, he had examined the behaviour of nickel, both loaded and unloaded, when subjected to various magnetizing forces. These show that the metal always contracts when magnetized. For no load the contraction at first increased with the magnetizing force, but attains a maximum. With a moderate load the contraction is less for small forces, but for larger forces becomes equal and then exceeds the contraction of the unloaded wire. For greater loads the contraction is less than when unloaded for all values of the force.—On Bertrand's Idiocyclophanous prism by Prof. S. P. Thompson. This hitherto undescribed prism is a total reflection one made of calc-spar, which shows to the naked eye the rings and crosses such as are seen when a slice of spar is examined by convergent light in a polariscope. The spar is cut so that the light after the first reflection passes along the optic axis, and after a second reflection emerges parallel to the incident light. The rings and brushes are present in pairs, but two pairs may be seen by tilting the prism to one side or the other. This was demonstrated before the Society. Prof. Thompson also exhibited a similar prism cut from quartz. Owing to the feeble double-refracting of the substance, no conspicuous rings could be seen, but when examined by the lantern traces of such rings were visible.—On the shape of the movable coils used in electrical measuring instruments, by Mr. T. Mather. The object of this note is to determine the best shape of the horizontal section of swinging coils such as are used in D'Arsonval galvanometers, electro-dynamometers, wattmeters, &c. Assuming constant period and constant moment of inertia about the axis of rotation, it is shown that for zero instruments, the best shape of the section is two circles tangential to the direction of the deflecting field at the point about which the coil turns. A table accompanies the paper, in which various forms of section are given, together with their relative deflecting moments per unit moment of inertia; the coils being taken of equal lengths and the current density constant. From this table it appears that ordinary D'Arsonval coils only give about 45 per cent. of the maximum deflecting moment, and ordinary Siemens' dynamometers from 40 to 53 per cent. The various assumptions made in the paper are shown to be justifiable in commercial instruments, and the modifications necessary in special cases are pointed out. Mr. C. V. Boys said he had, when working at his radio-micrometer, arrived at a shape similar to that recommended in the paper. He also noticed a peculiar relation true for all shapes where the length parallel to the axis of rotation is great compared with the breadth. Suppose a coil of any dimensions, then another coil of half the breadth and double the length and cross-section will be dynamically, electrically, and magnetically the same as the original; for the moment of inertia, the electric resistance, and the enclosed magnetic field are equal. The above relation is also true when the breadth is not small, if the cross-pieces be thickened near the axis so as to make their moment of inertia proportional to their length. He inquired whether the author had considered the subject of grading movable coils; he himself was of opinion that, unlike fixed galvanometer coils, the wire near the axis should be thicker than that further away. The President remarked that in 1881 Prof. Perry and himself exhibited a wattmeter at the Society of Arts, whose movable coil somewhat resembled one of those in the paper, which gave a deflecting moment of 95 per cent. of the maximum. In designing the instrument they had felt that the ordinary method of using a comparatively large swinging coil was not the best, and this led them to the shape adopted.

Entomological Society, April 2.—Mr. Frederick DuCane Godman, F.R.S., Vice-President, in the chair.—Mr. Godman announced the death of Dr. J. S. Baly, of Warwick, the well-known Coleopterist, who had been a member of the Society for the last forty years.—Dr. Sharp exhibited and made remarks on a female specimen of *Temnochila quadricollis*, Reitt., which was the subject of a very unusual malformation of the nature termed "ectromélie" by Lacordaire.—Mr. R. W. Lloyd exhibited three specimens of *Elater pomonæ*, taken at Brockenhurst about the middle of March last.—Colonel Swinhoe exhibited, and read notes on, a number of butterflies of the genus *Euthalia*. He pointed out that the specimens described as a species by the name of *Euthalia sedeva* were only the females of *E. balarama*.—Mr. T. R. Billups exhibited male and female specimens of *Cecidomyia salicis-siliqua*, Walsh, which had just emerged from galls received from Mr. Cockerell, who had collected them on a species of sallow in Colorado. He also exhibited three species of Ichneumonidæ new to Britain, viz. *Ichneumon haglundi*, Holmgr.; *Phygadeuon rufo-niger*, Bridg.; and *Phygadeuon sodalis*, Tasch.—Mr. C. G. Barrett exhibited specimens of *Bryotropha obscurella*, Hein, and *Doryphora elongella*, Hein, two species of Micro-Lepidoptera new to Britain.—Dr. Thallwitz, of Dresden, contributed a paper entitled "Notes on some species of the genus *Hilipus*." These notes had reference to a paper on the genus *Hilipus*, by Mr. F. P. Pascoe, published in the Transactions of the Society for 1889.—Mr. E. Meyrick read a paper entitled "The Classification of the Pyralidina of the European Fauna."—Prof. Westwood communicated a paper entitled "Notes on certain species of Cetoniidæ."—Mynheer P. C. T. Snellen, of Rotterdam, contributed a paper entitled "A Catalogue of the Pyralidæ of Sikkim collected by H. J. Elwes and the late Otto Möller," and Captain Elwes read notes on the foregoing paper as an appendix. Mr. W. L. Distant, Colonel Swinhoe, Mr. McLachlan, and Mr. Jacoby took part in the discussion which ensued.

Zoological Society, April 1.—Dr. A. Günther, F.R.S., Vice-President, in the chair.—The Secretary read a report on the additions that had been made to the Society's Menagerie during the month of March 1890; and called special attention to a fine example of a rare Passerine Bird (*Hypocolius amplinus*) from Karachi, presented to the Society by Mr. W. D. Cumming, Curator of the Museum, Karachi; and to two Mantchurian Cranes (*Grus viridirostris*), presented to the Society by Mr. C. W. Campbell, of H.B.M.'s Consular Service, Corea.—Mr. J. H. Gurney, Jun., exhibited and made remarks on a hybrid between the Tree-Sparrow (*Passer montanus*) and the House-Sparrow (*P. domesticus*), bred in captivity at Norwich.—Mr. W. B. Tegetmeier, exhibited a specimen of a Greek Partridge, shot in the Rhone Valley, and of an abnormal Viper.—Mr. A. Smith-Woodward exhibited and made remarks on a specimen of a Mesozoic Palæoniscid Fish from New South Wales, and pointed out that the structure of its pelvic fins seemed to confirm the recent opinion that the Palæoniscidæ are related to the Acipenseridæ and not to the Lepidosteidæ. The author believed the specimen exhibited to be the only one of the kind in existence.—Mr. C. M. Woodford made some remarks on the fauna of the Solomon Islands; and exhibited a large number of photographs in illustration of his remarks and of his recent explorations in these islands.—A communication was read from Dr. R. W. Shufeldt, entitled "Contributions to the Study of *Heloderma suspectum*," containing a complete account of the osteology and anatomy of this venomous Lizard. A list of the literature on the subject was added.—Dr. A. Günther, F.R.S., read the descriptions of new species of Deep-sea Fish from the Cape (*Lophotes fiski*), based on a specimen sent to the British Museum by the Rev. G. H. R. Fisk.—Mr. Edgar A. Smith, read a report on the Marine Molluscan Fauna of the Island of St. Helena, based principally on a large series of specimens collected by Captain Turton, R.E., and presented to the British Museum.—A second paper by Mr. Edgar A. Smith contained a report on the Marine Mollusca of Ascension Island.

Mathematical Society, April 3.—J. J. Walker, F.R.S., President, in the chair.—The following communications were made:—On the properties of some circles connected with a triangle formed by circular arcs, by Mr. Lachlan.—Some properties of numbers, by Mr. Christie.—The modular equations for $n = 17, 29$, by Mr. R. Russell. Communicated by Prof. Greenhill, F.R.S.

EDINBURGH.

Royal Society, March 17.—Sir W. Thomson, President, in the chair.—The President read a paper on an accidental illustration of the effective ohmic resistance to a transient electric current through an iron bar.—Prof. C. Michie Smith read a paper on the absorption spectra of certain vegetable colouring matters, the most interesting of which was a green colouring matter extracted from the pulp surrounding the seeds *tricosanthes palmata*. This substance is not chlorophyll, but is allied to it.—Prof. Smith also described a method of determining surface tensions by measurement of ripples. Ripples are set up on the surface of the liquid by means of a tuning-fork and the surface is then photographed along with a suitable scale. The lengths of the ripples can thus be obtained by micrometric measurements of the negative. The results obtained for mercury were very concordant, and agreed with the mean value obtained by Quincke. Strong electrification of the surface was found to reduce the value of the surface tension by more than 20 per cent. A few measurements of the surface tension of water also gave very fair results.—The Hon. Lord M'Laren read a paper on the solution of the three-term numerical equation of the *n*th degree.—The President read a paper, illustrated by a model, on a mechanism for the constitution of ether.

PARIS.

Academy of Sciences, April 8.—M. Duchartre in the chair.—M. Maurice Lévy, in a note on theories of electricity, shows that the formula given in his communication on March 17, representing the action between two moving electric particles, includes all the theories of electricity yet proposed, and that the values of an arbitrary constant required to satisfy each of the known theories are none of them competent to explain the movement of the perihelion of Mercury, whereas the latter is completely in accordance with the formula when another suitable value is chosen for the constant.—M. R. Lépine, in a note on the normal presence in chyle of a ferment destroying sugar, suggests that in the majority of cases of diabetes the disease is probably due to a defect in the production of this necessary body.—Observations of Brooks's comet (*a* 1890), made with the great equatorial of Bordeaux Observatory, by MM. Rayet, Picart, and Courty. The comet was observed on March 30 and 31, and

April 2 and 3.—Elements and ephemeris of Brooks's comet, by M. E. Viennet. Elements have been computed from observations at Cambridge, U.S., March 21; Kremsmunster, March 26; and Paris, March 31.—Observations of Brooks's comet, made at Paris Observatory, by Mdlle. D. Klumpke.—Fundamental common property of the two kinds of spectra, lines and bands; distinct characteristics of each of the classes; periodic variations to three parameters, by M. H. Deslandres. The facts relating to the periodic recurrence of doubles and triplets in spectra were previously given by M. Rydberg, and reduced to some simple laws (*Comptes rendus*, February 24). It was noted that the lines corresponding to doubles and triplets are represented by a function of whole numbers of the form $N = A - \frac{a}{(m+p)^2}$; where N is the number of waves; A, a, two constants; p a constant less than one, and m a whole number. This function has for a limit the more simple one $N = A - \frac{a}{m^2}$, which, when A and a have proper values, represents exactly, as was shown by Balmer, the unique series of the simple lines of hydrogen. The author states that the distribution of bands is in general more complex, the complete series of groups being represented by a function of three variable parameters, $m, n, p - N = f(n^2p^2) \times m^2 + Bn^2 + \phi(p^2)$; where m, n, and p, are whole numbers; B, a constant; f and ϕ some simple functions the study of which is not completed. N is a function of three parameters, but in certain spectra it is reduced to two or even one. This distribution depending on three parameters is a distinct characteristic of a band spectrum.—On the suppression of halos in photographic plates, by MM. Paul and Prosper Henry. *A propos* of a communication by M. Cornu (*Comptes rendus*, March 17), the authors note that in order to get rid of halos which occur around bright stars on an ordinary photographic plate they cover the backs of plates with collodion containing a small quantity of chrysoidine in solution.—Discharge of the two electricities by the action of ultra-violet light, by M. Edouard Branly. The author has obtained new results by using the induction spark as his source of light in place of the electric arc used by previous observers.—On phosphotrimetatungstic acid and its derived salts, note by M. E. Péchard.—On a nitroso-platinichloride, by M. M. Vèzes. By the action of an excess of hydrochloric acid on a concentrated solution of potassium platinonitrite, a body is obtained of the composition $PtCl_3(NO),2KCl$, analogous to but much less stable than the nitrosoruthenichloride, $RuCl_3(NO),2KCl$, described by M. Joly (*Comptes rendus*, t. cvii. p. 994). It is distinguished from the platinichloride under the microscope by its form and by its action on polarized light.—Glycollic nitrile and the direct synthesis of glycollic acid, by M. Louis Henry. The nitrile is formed by the addition of formic aldehyde to hydrocyanic acid, $HCOH + HCN = CN—CH_2OH$. The glycollic nitrile obtained is a very mobile, odourless, colourless liquid; its density at 12° is 1·100, it boils at 759 mm. pressure at 183° with partial decomposition. By hydrolysis with fuming hydrochloric acid, it yields glycollic acid, which may be separated as the calcium salt. This, in the opinion of the author, is the best method for the preparation of glycollic acid.

STOCKHOLM.

Royal Academy of Sciences, March 13.—On the International Zoological Congress in Paris in 1889, by Prof. F. A. Smitt.—A continuation of the Report of the Ornithological Committee, by Prof. F. A. Smitt.—On the results of the recent winter expedition for hydrographic researches in Skager Rack, by Prof. S. O. Pettersson.—Analytical deduction of the equations of the surfaces and lines which are invariants to the generalized substitution of Poincaré, and some geometrical properties of such invariant surfaces and lines, by F. de Brun.—On a special class of singular surfaces, by T. Fredholm.—On the solution of a system of linear resemblances between an infinite number of unknown quantities, by H. von Koch.—On a paper by H. Weber, entitled "Ein Beitrag zu Poincaré's Theorie der Fuchs'schen Functionen," by G. Cassel.—On the conform representation of a plane on a prism with some correlated problems, by the same.—Researches on mustard-oil-acetic acid and on thiohydantoin, by Prof. Klason.—Derivates of 1 : 3 dichlornaphthalin, by Prof. Cleve.—On the cyclic system of Ribaucour, by Prof. Bäcklund.—Contribution to the knowledge of the Ascomycetæ of Sweden, by C. Starbäck.—Determination of the optical rotation of some resinous derivates, by A. W. Svensson.—Studies on the influence of the irritation of the spinal chord and the nervus splanchnicus on the pressure of the blood with inductions of different frequency and intensity, by J. E. Johansson.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Evolution, Antiquity of Man, Bacteria, &c.: W. Durham (Edinburgh, Black).—Le Premier Etablissement des Néerlandais a Maurice: Prince Roland Bonaparte (Paris).—Le Glacier de l'Aletsch et le Lac de Märjelen: Prince Roland Bonaparte (Paris)—Pocket Meteorological Tables, 4th edition: G. J. Symons (Stanford).—The School Manual of Geology, 5th edition: A. J. Jukes Browne (Edinburgh, Black).—The Two Kinds of Truth: T. E. S. T. (Unwin).—The Art of Paper-making: A. Watt (Lockwood).—Catalogue of Books in the Library of the Indian Museum: R. L. Chapman (Calcutta).—Ueber die Liasischen Brachiopoden des Hierlatz bei Hallstatt: G. Geyer (Wien, Hölder).—Die Liburnische Stufe und deren Grenz-Horizonte, 1 Heft, Erste Abthg.: G. Stache (Wien, Hölder).—Advanced Physiography: J. Thornton (Longmans)—Ferrel's Convectional Theory of Tornadoes; Davis and Curry.—The Root-Knot Disease of the Peach, Orange, and other Plants in Florida (Washington).—The Fossil Butterflies of Florissant: S. H. Scudder (Washington).—The Photographic Quarterly, April (Hazell).—Journal of the Institution of Electrical Engineers, No. 85, vol. xix. (Spon).—Journal of the Chemical Society, April (Gurney and Jackson).—Société d'Encouragement, Paris, Annuaire 1890 (Paris).—Proceedings of the Academy of Natural Sciences, Philadelphia, Part 3, 1889 (Philadelphia).—Insect Life, vol. 2, Nos. 7, 8, 9 (Washington)—Journal of the Bombay Natural History Society, vol. 4, Nos. 3 and 4 (Bombay).—Ergebnisse der meteorologischen Beobachtungen, Jahrg. xi. (Hamburg).—Journal of Anatomy and Physiology, April (Williams and Norgate).—Jahrbuch der k.k. geologischen Reichsanstalt, Jahrg. 1889, 39 Band, 3 und 4 Heft (Wien, Hölder).

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