results unless plenty of ash constituents are present, phosphates as well as potash; paragraph 20, that phosphates are a highly desirable addition in the manuring of barley; and paragraphs 24 and 27, that both phosphates and potash should be used on potatoes and on grass-land when sulphate of ammonia is used to supply nitrogen.

The Committee is to be congratulated on having secured and published a very useful and very justly written essay.

Euclid. Books I.–IV. Edited by Charles Smith and Sophie Bryant. Pp. viii + 288. (London: Macmillan and Co., 1899.)

WITH this book we have another addition to the great number of text-books on the Elements of Geometry. Its chief features seem to be that the editors endeavour to instil into the students the notion that it is the correct reasoning and proof of the propositions which should be mastered, and not so much an exact repetition of the words of the text-book or teacher.

Abbreviations are freely used early in the first book, and these should be adopted generally by beginners, as the reasoning of a proof can be more easily scanned. The editors have in several cases departed from Euclid's solutions and adopted in their stead more modern and simple methods. Included in the text are many examples, both original and selected, from mathematical journals and examination papers. In this form the Elements should be found useful in many schools.

Sylvia in Flowerland. By Linda Gardiner. Pp. 198. (London: Seeley and Co., Ltd., 1899.)

AN attempt is here made to employ the methods of Lewis Carroll in the teaching of botany. In the first chapter the foxglove explains: "This is Leap Year with us (the flowers), and so we have a thirty-first of June," and because the thirty-first of June does not occur every year, it is a day of special favour to humans, who are allowed "to hear with both eyes and ears." Sylvia talks with plant after plant, and is instructed by them in the fascinating mysteries of cross-pollenation and many other interesting questions of plant-life. The jam is sometimes scarcely thick enough to hide the powder; but we have little doubt that the volume will find many appreciative readers.

Magnetism and Electricity. By J. Paley Yorke. Pp. viii + 264. (London: Edward Arnold, 1899.)

MR. YORKE'S object is to provide an introduction to this branch of physics for those students who already possess some acquaintance with general elementary science. His treatment is non-mathematical, and no precise instructions are given for experimental work. It is a little difficult to understand the reason for the interpolation of chapter v., headed "Electricity," between the subjects of magnetism and the study of electric currents, more especially as the subject of electrostatics is resumed in chapter xii. The explanations are clear and simple, and the book should give an intelligent reader sound preliminary conceptions of an important subject.

Field and Folklore. By Harry Lowerison. With a chapter on Folklore by Alfred Nutt. Pp. vii + 77. (London: David Nutt, 1899.)

THE collection of short essays on various aspects of nature-study collected here should do a great deal towards enlisting the sympathy of school teachers in developing a love in their pupils for outdoor observations of animal and plant-life. Mr. Lowerison gives, in an informal way, a series of useful hints as to how to set about observing nature, and what books to consult to find the explanation of observations which are not at first easily understood. Mr. Nutt's chapter describes the scope of folklore and the aims of students of this department of knowledge.

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.]*

The Stockholm Conference on the Exploration of the Sea.

I CANNOT refrain from addressing to you a few words in support of Prof. Herdman's remarks on the outcome of the Stockholm Conference. With marine biology so eminently represented at the meetings, there was ground for an expectation that the report would contain primarily recommendations for work at sea. The representatives of chemical and physical work appear to have known their minds and to have obtained the just recognition of their claims.

Hitherto in biological investigation work has been too exclusively devoted to the food fishes themselves—too little to the food of these fishes—far too little to their biological environment. It will be to many eager students, both of fishery affairs and marine biology, a matter of dismay if nothing more definite results from this Conference. There are, and have been, too many committees, secretaries and bureaus engaged on this subject. As Prof. Herdman says, we want work at sea. To be precise, we want, to begin with, two well-equipped trawlers and the right men in them. If the Stockholm Conference had recommended even one, it would have been a sign of grace. Such boats are not mere scientific instruments—not merely the luxuries afforded by governments in times of prosperity—but sound financial investments in fishery affairs. The Norwegian Government has, I understand, ordered one, admirably devised for marine investigation. GEORGE MURRAY.

November 25.

Bust of Sir George Stokes.

YOU were kind enough to say last June that Mr. Hamo Thornycroft would undertake the production of bronze copies of the presentation bust of Sir George Stokes, about one-third of the size of the original, at a cost of seven guineas each, in case twenty-five were ordered, and that names would be received by Sir William Crookes and myself.

If anybody wants such a copy I hope that he will write to me at once. JOHN PERRY.

Royal College of Science, London, South Kensington, S.W., November 22.

A Geometric Determination of the Median Value of a System of Normal Variants, from two of its Centiles.

A SHORT account appeared in NATURE, October 12, p. 584, of a paper read by me at the British Association, entitled the "Median Estimate," which will appear in the forthcoming Journal of the Association. Its object was to solve a problem of the following kind:—40 per cent. of the members at a meeting vote that a proposed grant should be less than 100*l.*, 80 per cent. vote that it should exceed 500*l.* What is the Median Estimate, supposing the normal law of frequency to hold good? That is to say, What is the sum that one-half of the members would think too little, and the other half too much, and which therefore presents the best compromise between many discordant opinions? I showed that the calculation was exceedingly simple if certain tabular values are used that will be spoken of later. But, on after reflection, it seems to me that further simplification is both desirable and feasible. The problem is representative of a large class of much importance to anthropologists in the field, few of whom appear to be quick at arithmetic or acquainted even with the elements of algebra. They often desire to ascertain the physical characteristics of races who are too timorous or suspicious to be measured individually, but who could easily be dealt with by my method. Suppose it to be a question of strength, as measured by lifting power, and that it has been ascertained that *a per cent.* of them fail to lift a certain bag A of known weight, and that *b per cent.* of them fail to lift another heavier bag B. From these two data, the median strength can be determined by the simple method spoken of above, and not only it but also the distribution of strengths among the people. Having indicated

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the utility and importance of the general problem, I will proceed to work out the particular case of the voters by the now further simplified method. In Fig. 2 let the base line G represent 100*l*. and let each successive horizontal line above it represent an increment of 100*l*. A dot A is placed on G, at the division 40°, and another dot B is placed on the ordinate at the division 80° at the level of the fourth line above G. Therefore A and B are plotted at their respective places. Join the two dots with a straight line. The place where this line cuts the ordinate at 50°, shows the Median value. The principle on which this exceedingly simple process rests must be explained by beginning with Fig. 1, where an ordinary curve of distribution is drawn about the axis H, with a quartile equal to 1. The

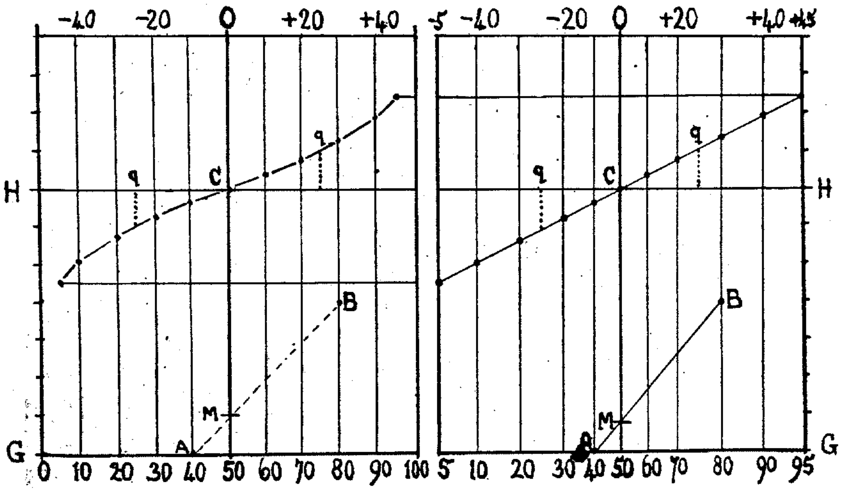

Fig 1. {Limits, 0° to 100°, otherwise, 0° to ±50°.
Fig 2 {Limits 5° to 95° otherwise 0° to ±45°

centiles from the axis to the curve are given in the following small table (see my "Natural Inheritance," Macmillan, 1889) which is reproduced here for convenience.

Centiles to the grades 0° *to* ± 50° (*negative for negative grades, positive for positive grades*).

±	0	1°	2°	3°	4°	5°	6°	7°	8°	9°
0°	0·00	0·04	0·07	0·11	0·15	0·19	0·22	0·26	0·30	0·34
10°	0·38	0·41	0·45	0·49	0·53	0·57	0·61	0·65	0·69	0·74
20°	0·78	0·82	0·86	0·91	0·95	1·00	1·05	1·10	1·15	1·20
30°	1·25	1·30	1·36	1·42	1·47	1·54	1·60	1·67	1·74	1·82
40°	1·99	1·99	2·08	2·19	2·31	2·44	2·63	2·79	3·05	3·45

The theoretical values for ± 50° are infinitely large.
The curve ceases to be trustworthy outside about ± 45°.

When A and B are plotted on Fig. 1 there can be only one normal curve of frequency whose steepness, as measured by its quartile, allows it to pass through both of them. This curve might be drawn, but by a tedious process of trial and error, to avoid which the arrangement shown in Fig. 2 has been devised, and the troublesome curve is dispensed with. The ordinates in Fig. 1 are so stretched apart or compressed together, laterally, that the curve is changed into a straight line. Let x be any abscissa in Fig. 1, counting from the middle of the axis to the right or left as the case may be, and let y be the corresponding tabular value. Then, as in Fig. 2, draw an abscissa x' of the same *nominal* length as x, but of a real length $=ny$, where $n=1$ or some more convenient number. Now let p_1, p_2, p_3, &c., be points on the curve in Fig. 1, having the co-ordinates x_1, y_1; x_2, y_2; x_3, y_3, &c., then the corresponding points in Fig. 2 will occupy positions having the co-ordinates of ny_1, y_1; ny_2, y_2; ny_3, y_3, &c. In other words, they will lie in the same straight line. The ordinates of any normal curve are expressed by multiplying the tabular numbers by the quartile of that curve. Let q be the quartile of any given curve, and write n' for nq. Then substituting n' for n in the above, we still find that p_1, p_2, p_3, &c., will lie in the same straight line in Fig. 2. Consequently the proposition is true generally.

Prof. Karl Pearson informs me that various curves representing technological formulæ were similarly translated into straight lines by Lalanne, and discussed by him in a series of papers (1846–1878). He termed the process by which a proper choice of scales enables us to represent a given curve by a straight line, *anamorphic geometry*. Prof. Pearson also tells me that in Lalanne's hands and in those of his followers (Hermann, Vogler, Kapteyn, &c.) this geometry has been of great service in exhibiting engineering and other data in a form suitable for easy reckoning.

A convenient scale for the pocket book may be made on a strip of paper squarely ruled in millimetres, on which the tabular numbers divided by 4 and multiplied by 100 are entered. Its range between ± 45° is consequently 100 × ¼ × (2 × 2·44) = 122 millimetres, which is less than 5 inches, or than the length of a half sheet of ordinary notepaper. The scale is to be used for plotting the values of a, b, and m, while the millimetre graduations along the opposite edge of the strip serve for the ordinates A and B. For frequent service, a ruled blank form, like Fig. 2, is quicker in use, and it need not, I think, be larger than half a sheet of foolscap paper, or eight inches wide. This would suffice to show clearly each alternate centile, as about the middle of the form, where the centiles lie closest together, the alternate centiles would be more than one-tenth of an inch apart.

An attempt is made at the bottom of Fig. 1 to exhibit the amount of error that would be produced by a simple interpolation between A and B, but it is better to make the comparison numerically.

Let a and b be the percentage of those who vote, &c., for less than A and B respectively, and let α and β be the tabular numbers *including their signs*, corresponding to a and b, on the scale reckoned from 0° to 100° (and not from 0° to ± 50°). Let m be the unknown median and q the unknown quartile of that curve of normal frequency which passes through the plotted positions of A and B, then

$$m + q\alpha = A \qquad m + q\beta = B.$$

Whence, by eliminating q, we have

$$m = A - \alpha\left\{\frac{B-A}{\beta-\alpha}\right\}, \text{ or } = B - \beta\left\{\frac{B-A}{\beta-\alpha}\right\}.$$

The "medians calculated" in the table below are thus derived. The simple interpolations require no explanation. Graduations on the scale 0° to ± 45° are in brackets.

	Values of b			
	(+20°) 70°	(+30°) 80°	(+40°) 90°	(+50°) 95°
a=20° (−30°)				
Medians calculated	348	300	259	236
Simple interpolation	340	300	271	260
a=40° (−10°)				
Medians calculated	231	193	167	154
Simple interpolation	233	200	180	173

The interpolated results are, of course, correct when A and B are symmetrically placed, as they are at 20° (−30°), and 80° (+30°). They are most incorrect when either A or B is near to the limits of the curve, and when both are on the same side of its middle point.

When applying the method practically, especially upon some unfamiliar characteristic whose law of frequency is doubtful, the determination of M should be considered as a first approximation, and the process be repeated with two new values A_1 and B_1, the one a little less, and the other a little greater than M. The new result M_1 could be accepted as final.

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For perfection of simplicity some method, whether it be graphic or tabular, for converting observed numbers into percentiles, might be printed at the back of the blank form.

FRANCIS GALTON.

On the Cause of Dark Lightning and the Clayden Effect.

I HAVE been criticised in a letter which appeared recently in NATURE for not alluding in my letter on dark lightning to the peculiar photographic reversal known as the Clayden effect. I must confess that at the time of writing my letter I was unaware of this effect, a description of which has only appeared, so far as I know, in one of the photographic journals. Mr. Clayden has certainly explained dark lightning, and it only remains to explain his explanation. As I think that this effect is not generally known, I believe that it may be worth while to devote a few words to the statement of the case before describing the experimental work by which I have determined the factors which play a part in this very curious photographic phenomenon.

Mr. Clayden showed that if a plate which had received an

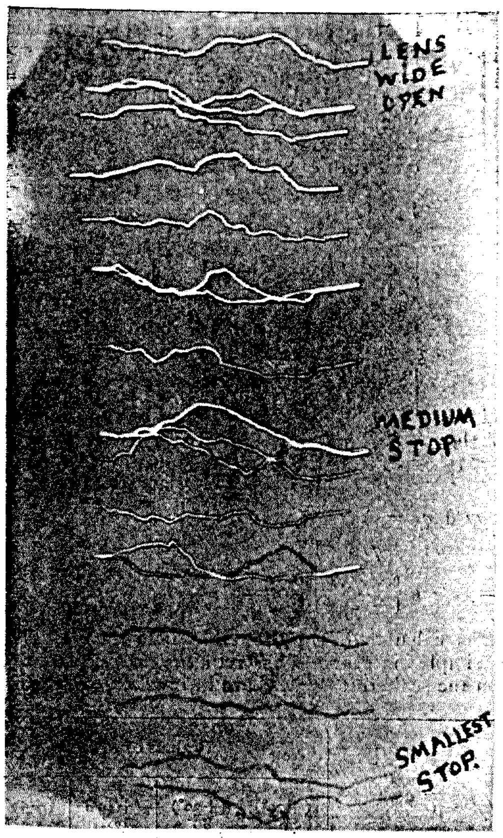

FIG. 1.

impression of a lightning flash or electric spark was subsequently slightly fogged, either by exposing it to diffused light or by leaving the lens of the camera open, the flash on development came out darker than the background. If, however, the plate was fogged before the image of the flash was impressed, it came out brighter than the background, as in the ordinary pictures of lightning. I refer to the appearance in the positive print in each case. This is quite different from ordinary reversal due to the action of a very intense light, for the order in which the lights are applied is a factor, and the phenomenon lies wholly in the region of under-exposure. I repeated Mr. Clayden's experiment, and obtained dark flashes without any difficulty.

The effect cannot, however, be obtained by impressing an image of the filament of an incandescent lamp on a plate, and subsequently fogging the plate. Clearly there is something about the light of the electric spark which is essential to the production of the reversal. It is not intensity, however, for I found that it was impossible to obtain reversed images of bright sparks with the lens wide open.

Fig. 1 shows a series of spark images, some normal, some partly reversed, and others wholly reversed. The sparks are those of a large inductorium with a good-sized Leyden jar in circuit. The sparks were all of equal intensity, but after each discharge the iris diaphragm of the lens was closed a little. It will be seen that the borders of the bright sparks are reversed. In some the image is reversed, with the exception of a narrow thread down the core. The images were impressed in succession on the plate by moving it in the camera. A plate holder was dispensed with, an opening being made in the ground-glass back by removing a strip a few centimetres wide. The plate was held against this opening, and a large number of exposures made in a few moments. Of course, the room was in total darkness. After exposure, the plate was exposed to the light of a candle for a second or two, and then developed.

In this series of pictures it will be seen that the edges of the bright images of the sparks are reversed, the intensity on the border of the image being less than at the core. As the intensity of the spark becomes less and less, the bright central core dwindles down to a mere thread, and eventually disappears, the spark's image being feeble enough to reverse over its entire area.

This explains why the dark lightning flashes are usually

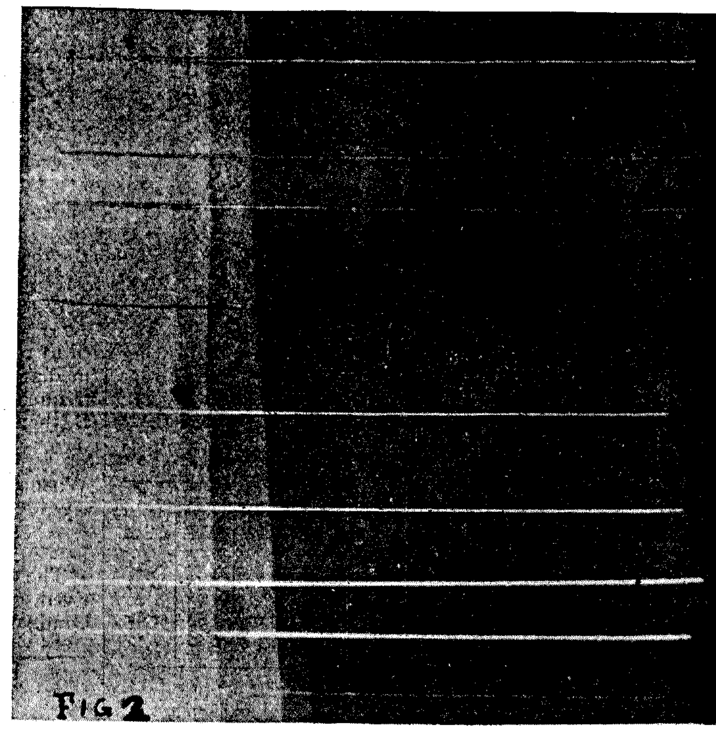

FIG. 2.

ramifications of the main flash. The ramifications are less brilliant discharges and reverse, while the main one is too bright to cause the effect.

The first thing that occurs to one is that it may be some peculiar radiation, which the spark emits, which is wanting in the light coming from other bodies. If a small photographic plate is partly screened by a piece of black paper and illuminated by the light of a small spark at a distance of two or three feet, and a similar plate, screened in the same manner, is illuminated for a moment by candle light of sufficient intensity to produce the same amount of blackening on development, we shall have the means of showing that the spark light differs in its action on the plate from that of the candle. If these two plates, before development, be half-screened in a direction at right angles to the former one, and exposed to the light of the candle for a second or two, the part of the plate which has been illuminated by spark light plus candle light does not become as black on developing as the part which has received candle light alone, whereas the part which has been twice exposed to candle light is blacker than that which has been only exposed once. This shows that the light of the spark does not act in the same way as the light of the candle. Wherein

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