

Letters to the Editor.

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Phenomena of "Intelligence" in the Protozoa.

I REGRET to observe the spirit of the letter in which Mr. Dunkerly (NATURE, May 26, p. 395) replies to Mr. Ludford, though, as being primarily responsible for the statement of the theory suggested, and periodically referred to of late years, I fully realise how extremely careful one should be in the choice of words in conducting the discussion. There is probably no theory occupying the attention of zoologists in connection with which the motto of the Royal Society, "Nullius in verba," applies with greater force. Unfortunately, the "journalistic instinct" of many writers on scientific subjects has led them to credit observers with views which they have—to put it mildly—not yet reached, and to saddle them with responsibilities which they have never assumed. For instance, in Prof. Boycott's letter on the same page he credits my friend Earland with my views on "the selective intelligence of the Foraminifera," which is the one subject upon which my esteemed collaborator does not entirely agree with me.

The term "gregarious instinct" used by Mr. Ludford is an unfortunate one. The "grouping" of Protozoa to which he refers must be considered with a cautious appreciation of the elements of (a) fear, (b) reflex action, and (c) surface tension, but the most indignant opponent of my views will scarcely deny that the sense of fear is perhaps the most elementary phenomenon dependent upon a sensory system. It is, no doubt, related to, but it must not be confounded with, the "intelligence" displayed by many arenaceous Foraminifera in building their tests of *adventitious* material, and in using that material in such a manner as to protect the surface of the test from naturally incidental dangers of damage, and to protect the apertures of the tests against the entrance of predatory parasites.

The "grouping" to which Mr. Ludford directs attention must not be confounded with the associations of marine Rhizopoda, which gain protection against suffocation in soft muds by the co-operative use of spicules, arranged as catamaran spars to maintain them upon the surface (as in *Psammospaera rustica*, H.-A. and E.), or with the aggregation of simple arenaceous tests for purposes of strength and protection, which, unfortunately, has led some of the earlier rhizopodists to treat such associations as new genera or species. It is as if they were to describe a litter of little pigs huddled together for warmth (which is an elementary phenomenon of intelligence) as a new and "polythalamous" genus of pig.

EDWARD HERON-ALLEN.

Large Acres, Selsey, May 31.

An Algebraical Identity $4X=Y^2-37Z^2$.

THE following is a well-known theorem derived from the theory of numbers. Let p be any ordinary odd prime, and let $X=(xp-1)/(x-1)$; then there is an algebraical identity

$$4X=Y^2 \pm pZ^2,$$

where Y, Z are polynomials of degree $\frac{1}{2}(p-1)$ and $\frac{1}{2}(p-3)$ respectively; and the sign of the ambiguity is + or - according as p is of the form $4n+3$ or $4n+1$. The cases up to $p=31$ inclusive have been published; the result for $p=37$ has just been communicated to me by Pundit Oudh Upadhyaya,

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research scholar of the University of Calcutta. He finds that

$$4X=Y^2-37Z^2$$

with

$$\begin{aligned} Y &= 2x^{16} + x^{17} + 10x^{16} - 4x^{15} + 15x^{14} - 5x^{13} + 17x^{12} - 8x^{11} \\ &\quad + 11x^{10} - 4x^9 + 11x^8 - 8x^7 + 17x^6 - 5x^5 + 15x^4 - 4x^3 \\ &\quad + 10x^2 + x + 2. \\ Z &= x^{17} + 0x^{16} + 2x^{15} - x^{14} + 3x^{13} - x^{12} + 2x^{11} - x^{10} \\ &\quad + 2x^9 - x^8 + 2x^7 - x^6 + 3x^5 - x^4 + 2x^3 + 0x^2 + x. \end{aligned}$$

I have tested this result in various ways, and have no reason to doubt its correctness.

It should be noted that Y may be obtained by expanding $2(x-1)^{18}$, and reducing the coefficients to their absolutely least residues mod. 37. It would be interesting to know the least value of p for which this rule does not apply. It must be less than 61.

G. B. MATHEWS.

7 Menai View, Bangor, May 29.

Atmospheric Refraction.

THE following proposition regarding the effects of refraction may be known, but I do not remember to have seen it stated. It is: "The course of a nearly horizontal ray of light in the lower part of the atmosphere is a circular arc having a radius of 14,900 geographical miles."

The velocity of light in that lower part of the atmosphere for which the decrease of pressure with the increase of height is nearly linear is given by the relation

$$v_h = v_0 \left(1 - a \frac{H-h}{H} \right),$$

where v_0 is the velocity in *vacuo*, v_h the velocity at the height h above the ground, and H the height of

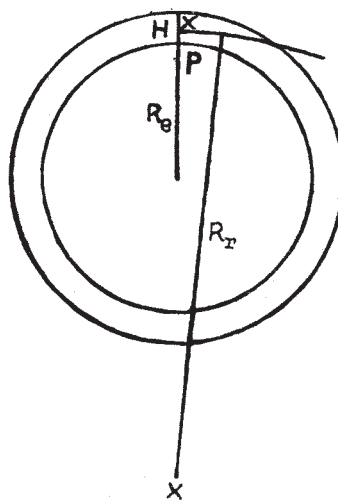


FIG. 1.

the homogeneous atmosphere ($a=0.00029$ nearly). At ground level the velocity is $v_0(1-a)$.

Let a plane vertical wave surface start from P as in Fig. 1. After the lapse of the time t it will have advanced $v_0 t$ at the height H , and $v_0(1-a)t$ at the surface of the ground. (This assumes the linearity of the relations between v_h and h to hold up to H , and though this is not true, the conclusions drawn from the assumption are correct, at any rate up to a few thousand feet.)

Thus at the time t the wave surface will be inclined forward, making an angle

$$\frac{v_0 - v_0(1-a)}{H} t, \text{ or } v_0 \frac{a}{H} t,$$

with the surface at P. Since this angle is directly proportional to the distance between the two wave surfaces, the normal at any point—that is, the direction of the ray—varies at a constant rate, and is therefore the arc of a circle. If $v_0 t = x$ and R_r is the radius of this circle (which may be called the refractive radius),

$$R_r x \frac{a}{H} = x, \text{ so that } R_r = \frac{H}{a}.$$

In geographical miles $H = 4.32$ about, which makes

$$R_r = 14,900 \text{ miles.}$$

The course of the ray is the same as it would be if it passed through an infinite number of vertically placed acute prisms of height H , having a refractive index $\mu_0/(1-a)$, with their bases occupying the whole surface of the ground. Since for horizontal rays these prisms are in the position of minimum deviation, rays which are pointed a few degrees up or down will still be arcs of the circle with 14,900 miles radius. The usual tables for the distance of the sea horizon assume that the horizon is x miles distant, when the height of the eye (h) = $\frac{x^2}{2 R_e}$, R_e being the earth's radius.

If refraction is taken into account,

$$h = \frac{x^2}{2} \left(\frac{1}{R_e} - \frac{1}{R_r} \right),$$

or, in numbers, without refraction,

$$h = 0.87 x^2;$$

with refraction allowed for,

$$h = 0.67 x^2.$$

Thus the sea horizon viewed from a height h , or a mountain of this height just visible from sea-level, is a good deal further off than the ordinary tables would indicate.

If an atmosphere of the same height and density as that of the earth covered a globe of 14,900 miles radius, an elevation at any one point of its surface would be visible from every other point, and a light at one end of a diameter would appear to an observer at the other end as a bright line extending round the whole of his horizon. A. MALLOCK.

9 Baring Crescent, Exeter, May 12.

Young's Interference Experiment and the Spectrometer.

IN NATURE of April 28, p. 268, Dr. R. A. Houstoun directs attention to the use of the spectrometer for Young's double-slit experiment. In a letter on "The Visibility of Interference Fringes and the Double Slit" (NATURE, July 26, 1917, vol. xcix., p. 424) the present writer made reference to a similar optical arrangement. In that letter emphasis was laid, not on the advantages of the method for observing fringes and evaluating wave-length, but on its use for studying the changes in the visibility of fringes which occur as the width of the spectrometer slit is altered. In view of Prof. Michelson's recent use of the double slit for the measurement of the angular width of distant stars, I may be pardoned for directing attention to my note of some years ago, and for pointing out the ease with which an experiment similar in method to that of Prof. Michelson may be performed by means of an ordinary spectrometer. It is true that, instead of using a source of fixed (but finite) width and a variable double slit, the converse arrangement was employed, but in principle the methods are identical. It might be worth while, however, to vary the experiment by replacing the spectrometer slit by a small circular aperture and using a double slit of variable width.

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May I also point out that the spectrometer may be used advantageously for an experiment on the limit of resolution of a telescope? It will be recalled that in the standard experiment a distant piece of gauze of fairly large mesh is viewed through a telescope before the objective of which an aperture is gradually narrowed until one set of wires disappears. If the slit of the collimator of a spectrometer be removed and in its place a piece of gauze of fine mesh be substituted, a much more convenient arrangement is available. During the past winter I found that students make quantitative measurements with such an arrangement without even darkening the laboratory.

In conclusion, it is well to note that for much of the above work even a spectrometer is not necessary. A telescope, a good lens, and adjustable slits are the only essentials.

JOHN K. ROBERTSON.

Queen's University, Kingston, Canada,

May 12.

The Reparation Act and Scientific Research.

THE columns of NATURE could, no doubt, be crowded with complaints concerning the Reparation Act, but as a sufferer I may be permitted to give the following instance of the extraordinary way in which this Act is used to hinder research.

I ordered a case of chemicals from Germany for myself and other workers in the Biochemical Laboratory, Cambridge, on February 2. In order that these should not come under the Reparation Act, they were dispatched on March 24 and arrived on April 8. Although the Reparation Act did not come into force until April 15, the goods were seized at Grimsby, and after a week's delay I was asked for all the original documents showing that the goods were ordered before March 8 and delivered before April 15. These were at once sent to London, but no reply was received from the Customs until I was forced to request the Medical Research Council, for whose work the chemicals were required, to apply to the Customs to free the goods as soon as possible. After three weeks' delay I received a letter from the Customs saying that the original documents were insufficient, and that a statutory declaration was required to confirm the particulars and to prove that the contract had not been fulfilled. This necessitated two visits to a commissioner of oaths and the preparation of a lengthy manuscript document adorned with red seals, the cost of which I have still to discover. This evidence was forwarded to the Customs a fortnight ago, and I have received no answer. The goods are still at Grimsby, the work of several people is being delayed, and the goods will apparently remain impounded (although they never came under the Act) unless I am prepared to submit to what might almost be called blackmail. To obtain the chemicals I must pay the full 50 per cent. myself, the funds of the Medical Research Council being unavailable for the purpose, and I must trust to recover the money from the Customs when my claim has been recognised—evidently a very doubtful eventuality.

All this delay, the expense, including the commissioners of oaths, not to speak of the worry and waste of time of an interminable correspondence, are apparently due to nothing but the red tape of a Government office.

H. ONSLOW.

May 27.

British Laboratory Ware and Chemicals.

THE question of the quality, supply, and prices of British laboratory glassware, porcelain, and chemicals, including research chemicals, is under consideration by a committee of the British Science Guild. The