

LETTERS TO THE EDITOR.

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Cancer and Parthenogenesis.

MAY I be allowed to refer to the interesting and stimulating discoveries of Messrs. Farmer, Moore and Walker, and Drs. Bashford and Murray? The former have demonstrated that nuclear changes occur in cancerous tissues, by which cells of malignant growths may be justly considered homologous to active sexual elements ("gametoid"). Giant cells are suggested to be "fusion-figures" which recall normal fertilisation (*sic*) in cancer.

I write to ask if botanists or zoologists are of the opinion that "post-heterotypic" cells (homotypic) are "inclined" at all to develop without fertilisation by the spermatozoon (i.e. by parthenogenesis from ? chemical stimulus).

Does parthenogenesis occur in the embryosac of flowering plants or in the prothallium of the higher cryptogams under any and what conditions?

On what known states does parthenogenesis in the eggs of the honey bee, in *ascaris*, in *artemisia*, &c., depend?

This sexual character of the cells of cancer explains partly its parasitic and invading nature; the wonderful power of mimicry of the tissues from which they originate suggests that metastases commence as cells self-fertilised and maturing. A knowledge of the (? chemical) causes underlying both these changes might afford a clue to prevention.

F. BUSHNELL.

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In reply to the queries contained in the letter of Dr. Bushnell, it may at once be said that parthenogenesis is known to follow the application of certain stimuli in the case of a few animals and plants, Loeb's experiments on sea-urchins and Nathansohn's observations on *Marsilea* furnishing instances to the point.

Parthenogenesis occurs in the embryosac of species of *Alchemilla*, perhaps also in some species of figs, but the underlying conditions are not yet understood.

In other examples of parthenogenesis, as noted in animals, it arises in consequence of the lack of separation of the second polar body from the egg, or follows on the re-fusion of it with the egg. This represents, perhaps, a modified kind of fertilisation. Apogamy as occurring in ferns is a more remote event, but is apparently possessed of a similar significance.

I quite agree with Dr. Bushnell as to the importance of reaching an understanding of the chemical and other agencies that produce the change in cells previously normal, and the concluding paragraph of the article to which he refers emphasises this side of the subject.

J. B. FARMER.

Magdalen College, Oxford, February 13.

On a Dynamical System illustrating the Spectrum Lines and the Phenomena of Radio-activity.

By the study of a system of particles, which is similar to a Saturnian system, I was led to the discussion of disturbances which propagate in the system, having close analogy with the band and line spectra while illustrating the phenomena of radio-activity. The system consists of a large number of particles of equal mass arranged in a circle at equal angular intervals, and repelling each other with forces inversely proportional to the square of distance between the particles; at the centre of the circle is placed a large particle attracting the other particles forming the ring according to the same law of force. If the repelling particles be revolving about the attracting centre, the system will generally remain stable for small oscillations, which consist of the transversal vibration perpendicular to the plane of the orbit, together with the radial and angular disturbances representing the rarefaction and condensation in the distribution of the particles. Small oscillations of this kind have already been treated by Maxwell in his essay

on the stability of Saturn's rings; the system will be the same if the repelling particles of the present system be substituted by the attracting satellites. Evidently the system here considered will be approximately realised if we place negative electrons in the ring and a positive charge at the centre. Such an ideal atom will not be contradictory to the results of recent experiments on cathode rays, radio-activity, and other allied phenomena.

The frequency of the transversal vibration is given by

$$n = \omega - am^2 + bm^4 + \dots,$$

where ω is the principal term and m the whole number. Plotting the lines of frequency, we find the crowding of lines when the value of m is small and when it is large. Generally the coefficient $a > 0$, so that with increasing m the frequency decreases, and the interval between the lines becomes wider. The distribution of lines resembles that of a band spectrum proceeding from violet towards the red. Taking the converging point of the lines for large values of m as the beginning, it is convenient to count the lines from the point, which I suppose to correspond to $m = m_0$. Then putting

$$m = m_0 - m'$$

we obtain, remembering that $\delta n = 0$ for $m = m_0$,

$$n = \omega' + a'm'^2 + b'm'^4 + \dots$$

n increases with m' , and the distribution resembles the band spectrum of carbon type, the interval between the lines gradually widening from red towards the violet. In fact, the above equation is an extension of Deslandres's formula.

If we suppose that the particles are negative electrons, we can easily prove that the transversal vibration will not be sensibly affected by the external magnetic field. This is another characteristic of the band spectrum.

The radial and angular waves propagating round the ring have frequencies given by

$$n = \frac{C}{\sqrt{1 - Am^2 + Bm^4 + \dots}}$$

The distribution of lines is such that they crowd together for tolerably large values of m towards a region of high frequency, and is in its general aspect similar to a band spectrum, with the difference that the interval between the successive lines is about nine times wider than in the band spectrum above described. This we may identify with the line spectrum, although m is not the same as in the formula of Kayser and Runge, or of Rydberg. The supposition that the particles are electrons leads to the conclusion that a single line is separated into doublets, circularly polarised in opposite senses.

The ring here considered is quasi-stable. It may be set to disturbances the radial and angular components of which are nearly proportional to

$$e^{i\kappa\nu t},$$

where κ is a constant, ν the number of particles in a ring, and t the time. If the disturbance continues for a sufficiently long time, the ring will be torn asunder and the system will fly off with great velocity. If the particles are electrons, those in the ring will give rise to β rays, and the central positive charges will form the α rays.

The ideal atom here considered will have high atomic weight when ν is large; consequently the instability is easier to produce when the atom is massive. Where there are several series of regular spectra we shall have to consider different rings of particles giving rise to these different sets. The complexity of spectrum is by no means a guarantee for the heaviness of atom; on the contrary, if high atomic weight is accompanied with comparatively simple spectral structure, we may consider that the system of rings is less complex, and ν may be quite a large quantity. This probably accounts for the remarkable radio-active property of radium, which, in spite of its high atomic weight, presents only a certain number of characteristic spectrum lines.

The kinetics of the system here considered may be extended to investigations which have analogies with the flutings of spectrum lines. Considered as electrons, the phenomena of actino-electricity, the ionisation of flames, the change of resistance of semi-insulators by exposure to light, the problem of coherer, the phenomena of fluorescence and