NOTES.

AN ATTEMPT TO ESTIMATE THE VITALITY OF SEEDS BY AN ELECTRICAL METHOD. By AUGUSTUS D. WALLER, M.D., F.R.S.—The present observations form part of an extensive series of experiments, by which I am engaged in verifying whether or no 'blaze currents' may be utilized as a sign and measure of vitality.

An inquiry of this scope necessitates superficial examination of many varieties of animal and vegetable matter, and the closer study of certain favourable test-cases.

I have selected as such a test-case the 'vitality' of seeds, and have chosen for my purpose beans (*Phaseolus*), which are anatomically convenient and practically easy to obtain of known age.

But before entering upon the results in this particular test-case, I think it advisable to preface those results by a brief indication of the principle involved in all such experiments.

By 'blaze current' (the term which I was led to adopt by the study of retinal effects) I mean to denote the galvanometrical token of an explosive change locally excited in living matter. An unequivocal blaze current electrically excited is in the same direction as the exciting current, i.e. it cannot be a polarization counter-current. (An equivocal blaze current, in the contrary direction to the exciting current, i.e. not at first sight distinguishable from a polarization counter-effect, also exists, but is not taken into consideration in this communication.)

The presence of an unequivocal or homodrome blaze current is in my experience proof positive that the object under examination is

¹ Abridged from the paper in Proc. Roy. Soc., vol. lxxviii, p. 79, 1901.

alive. Absence of the effect is strong presumptive evidence that the object is 'dead,' or rather not-living. It may be in that paradoxical state of immobility which we characterize as latent life, and which we may not characterize as the living state, inasmuch as no sign of life is manifested, nor as dead, inasmuch as the living state can be resumed. An object in this dormant state exhibits no 'blaze current' or other sign of life. And although it has capacity of life, and cannot therefore be classed in the category of 'dead' things, it is not actually living, and must therefore logically be classed in the more extensive category of not-living things.

Limiting ourselves to the unequivocal blaze current as the criterion between the living and not-living states, we may formulate the following practical rule for a summary interrogation of any given object:—

If the after-currents aroused by single induced currents of both directions are in the same direction, the object investigated is alive.

Typical Experiment.—A freshly shelled out and unbruised bean set up laterally between unpolarizable electrodes gives—

1. Blaze currents in the positive direction in response to an induction shock in the positive direction; and in the negative direction in response to an induction shock in the negative direction.

2. The same bean, after removal of a horizontal slice from its under-surface B (giving therefore current of injury of positive direction), gives blaze currents in the negative direction in response to an induction shock in the positive direction (= an equivocal blaze in the polarization direction) and to an induction shock in the negative direction (= an unequivocal blaze in the homodrome direction). If the bean is horizontally sliced at the upper surface A instead of at the lower surface B, the current of injury is negative and the blaze currents positive in response to both directions of excitation.

3. A boiled bean gives no blaze currents in either direction, but only small polarization counter-currents, in the positive direction after a negative current and in the negative direction after a positive current.

The next obvious point to be tested is the effect of anaesthetics upon the response. The results depend upon strength of excitation employed, and duration of anaesthetization. *Caeteris paribus*, the strong effect of a strong stimulus is far more refractory to the action of an anaesthetic than the smaller effect of a weaker stimulus, and in

the former case the suppression is apt to be incomplete, or when complete to be definitive. To obtain temporary suppression it is necessary to choose a sufficient but not too strong exciting current, and to anaesthetize by ether rather than by chloroform.

In a preceding paragraph it has been mentioned that a fresh vigorous seed gives a large blaze current, whereas a stale or moribund seed gives little or no response. The next step was obviously to compare similar seeds submitted to various enfeebling modifications, as well as different crops of similar seeds, the electrical tests being controlled by parallel germination tests.

The first and most readily effected comparison is that between the reactions of fresh seeds and of the same seeds killed by boiling. The result of this comparison is unmistakable and invariable. Fresh seeds giving unequivocal blaze currents with an E.M.F. of 0.01 to 0.10 volt give no blaze currents whatever after they have been boiled, but only polarization counter-current with an E.M.F. of 0.0005 to 0.0020 volt. The seeds upon which I have made this test have been leguminous seeds such as shelled beans and peas boiled in water, and the kernels of stoned fruits such as cherries, plums, and peaches boiled in their protected state.

Table I.—Comparison between beans of the years 1895 to 1899. Forty-eight hours' soakage at room temperature. Average of 10 seeds of each year. Germination test not made.

	1895.	1896.	1897.	1898.	1899.
Weight of 10 seeds—	grammes.				
Before soaking . .	6.2	5.8	6.2	3.3	4.8
After soaking . .	13.9	7.6	12.5	6.4	10.5
Average blaze .	0.0014	0.0036	0.0043	0.0052	0.0170

Table II.—Twelve intact beans of 1895, soaked in water at 24° for twelve hours, then laid on wet flannel in incubator for a further twelve hours at 24°, measured electrically on December 17, and forwarded to Kew for independent test by germination. I have to

thank Sir W. Thiselton-Dyer for the account of their subsequent behaviour.

	<i>Blaze reactions.</i>	<i>Subsequent behaviour at Kew.</i>	
		<i>Date of germination.</i>	<i>Condition.</i>
Bean No. 1 . . .	0.0050	December 28	Weak ¹ .
„ 2 . . .	0.0025	Failed	
„ 3 . . .	0.0175	December 22	Strong.
„ 4 . . .	0.0125	December 27	Moderate.
„ 5 . . .	0	Failed	
„ 6 . . .	0.0100	December 22	Strong.
„ 7 . . .	0	Failed	
„ 8 . . .	0.0100	December 25	Strong.
„ 9 . . .	0	Failed	
„ 10 . . .	0.0050	December 31	Weak ¹ .
„ 11 . . .	0.0100	December 24	Strong.
„ 12 . . .	0.0100	December 24	Strong.

CONCLUSION.

The physiological character of the blaze reaction is proved (1) by the influence of raised temperature ; (2) by its general parallelism with germination tests ; (3) by the influence of lowered temperature ; (4) by the influence of anaesthetics ; (5) by the influence of strong electrical currents ; (6) by the absence of blaze and failure of germination in the case of waterlogged seeds. In every instance a bean giving no blaze gave subsequently no sign of germination.

There has been throughout these first observations a general, but not faultless, correspondence between the blaze reaction and the germinative activity. The correspondence is such as to make good the principal fact that the blaze reaction is a sign of life, and that its magnitude is some measure of what we designate as 'vitality.' The defects of correspondence may have been due to irregularities in the results of the blaze test, or of the germination test, or of both tests. As regards great differences of vitality, both tests are obviously and in every case concordant, both replying by an indubitable 'yes' or 'no'

¹ Those marked weak are not likely to get beyond the cotyledon stage.

to the question whether there is blaze and germination. As regards the lower degrees and the smaller differences of vitality, the chances of disagreement between the two tests are obviously greater. As regards the electrical test, it is more difficult to take the measure upon the entire seed than upon its isolated radicle. As regards the germination test, it is not always easy to ensure identical and optimum conditions.

Fresh and vigorous seeds manifest a large blaze response (0.0500 volt or more), and germinate strongly. Older and less vigorous seeds manifest a smaller blaze (0.0100 volt or less), and a less active germination. Still older seeds, incapable of germination under even the most favourable conditions, manifest still smaller blaze (0.0010 volt or less), and finally none at all, or the small counter-effect due to polarization (0.0005 volt more or less).

THE QUADRIPOLE SPINDLE IN THE SPORE-MOTHER-CELL OF *PELLIA* EPIPHYLLA.—I have read with interest the account of nuclear division in *Pellia* as given by Prof. Davis in the last number of this journal¹, and it is a source of gratification to find that his description of the processes accords so nearly, at any rate as regards matters of fact, with that given by me in 1894 and 1895². But in dealing with the first mitosis in the spore-mother-cell, he has arrived at conclusions respecting the peculiar spindle so characteristic of the earlier stages, which diverge considerably from those which I expressed in the second paper above cited. As the matter is not merely one of detail only, but is of great cytological interest, it seems desirable briefly to examine the evidence adduced by Prof. Davis in support of his own contention.

He apparently regards the quadripolar spindle, described by me, as non-existent ('there is no four-poled spindle,' p. 174), and he was not able to trace any structures in the cell of the nature of centrosomes in connexion with the mitosis under consideration. The first of these objections seems to depend chiefly on the mode of interpretation adopted, the latter more nearly touches upon fact.

Now, as regards the failure to identify the centrospheres at this stage, I can only assert that they are certainly to be distinguished in appropriately prepared sections, although they are by no means

¹ Annals of Botany, xv, No. LVII.

² Ibid., viii and ix.

Waller, Augustus Désiré. 1901. "An attempt to estimate the vitality of seeds by an electrical method." *Annals of botany* 15, 427-431.

<https://doi.org/10.1093/oxfordjournals.aob.a088823>.

View This Item Online: <https://www.biodiversitylibrary.org/item/236929>

DOI: <https://doi.org/10.1093/oxfordjournals.aob.a088823>

Permalink: <https://www.biodiversitylibrary.org/partpdf/318627>

Holding Institution

Smithsonian Libraries

Sponsored by

Biodiversity Heritage Library

Copyright & Reuse

Copyright Status: Not in copyright. The BHL knows of no copyright restrictions on this item.

This document was created from content at the **Biodiversity Heritage Library**, the world's largest open access digital library for biodiversity literature and archives. Visit BHL at <https://www.biodiversitylibrary.org>.