Further Measurements on the Bioluminescence of the Seedlings

The introduction and the development of the photomultipliers in the technique of light detection has permitted the counting of individual photons corresponding to extremely feeble luminous fluxes. This method of detection can be applied with advantage to the study of problems connected with feeble luminous emissions; photons come directly from molecules that take part in some reaction, chemical or biochemical for instance, and can be very useful in furnishing a clue to molecular processes.

By means of a very sensitive apparatus, some of us have detected recently the emission of light in the visible spectrum by various germinating plants. The present work is concerned with specifying such preliminary results, discussing some further properties of luminescence, giving a quantitative comparison of the intensity of the emitted light for different plants and at various ages during the germination, and showing that the production of light is strictly connected with the vital functions of seedlings.

(1) The apparatus used in the present research work is the same described in previous papers. It is possible with this device to detect the light coming from a big emitting area or volume. The plants used for present experiments belong to graminaceous and leguminous families. The seedlings were grown in complete darkness and reproducible for a period of months.

The seedlings grew in humid surroundings at a constant temperature of 25°C. Measurement were conducted both on whole plants and on cold water extract of the plants or of the separate organs.


In the Table, the results obtained are set down. Both the plant and the phototube were at room temperature (20°C) throughout the measurement.

The results show clearly the existence of bioluminescence, and the activity observed is much greater than the thermoelectronic background of the photomultiplier. We should remark that the background is very stable and reproducible for a period of months.

The measurements repeated many times show a good reproducibility in a factor 2, but a measurement of this kind does not make possible a precise comparison.
of the intensities of light produced by various seedlings by reason of the absorption of light inside the seedling itself.

The last line of the Table shows that the activity of the cut seedlings multiplies two- or threefold in comparison with that for a normal one.

Later we carried out measurements to compare the luminescence intensity of various seedlings of different ages, by using the cold water extract previously described.

It was found that the light intensity of the extracts is reduced in the course of time to about one third beginning from the fifteenth to the thirtieth minute after starting of the operations of preparation; thereafter it remains sufficiently constant for hours.

Both the manner of intensity diminution as well as the further behaviour were found to depend on the quantity of air contained in the liquid.

By repeating the preparatory operation in a regular manner, a good reproducibility of the results was obtained, and therefore the average number of pulses per minute between the fifteenth and thirtieth minute was considered as a convenient index of the intensity of light emitted by the sample.

On Figure 1 are given the average intensities for various plants at various ages until the fifteenth day of their growth. The measurements were made on samples of equal weight and therefore the numbers of pulses of Figure 1 indicate the light emission of weight units of the seedlings (specific emission intensity).

As will be noted, the specific emission increases rapidly after the second day and reaches a maximum more or less around the fifth day.

The two leguminous plants studied have a higher specific activity than the two gramineous plants.

In Figure 2 the specific emission of extracts of various organs of lentil seedlings at different ages are shown. It will be seen that the roots have a much greater specific light intensity than the other organs.

In Figure 3 the dependence of the luminescence on the pH value of the solution is shown. The values are obtained with seeds of lentils.

Finally, the spectral distribution of the emitted light was studied in respect to various plants, both as extracts as well as entire seedlings, by means of a series of coloured Wratten filters. Figure 4 shows the results, the values having been corrected for the photocathode yield.

(3) The sum of these results indicates with certainty the connection of the light emission with the vital functions of the plant. The interpretation of the empirical behaviour reported above is not possible at this early stage of the research; we think that these results will be of aid in understanding the nature of the luminescent reaction.

It should be noticed that we examined some other seedlings, finding in any one case more or less intense light emission; it seems that the luminescent reaction is common to many kinds of seedlings.