Letters to the Editor.

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Selective Action of Polarised Light upon Starch Grains.

IN a recent note (*Annals of Botany*, 39, 651, 1925) Prof. Neilson Jones has criticised our statement (*Proc. Roy. Soc.* 97 B, 250, 1924) that starch grains are selectively hydrolysed by polarised light in the presence of small quantities of diastase. Prof. Jones is under a misapprehension when he says that we accepted the frilling or serration of the grains as evidence of hydrolysis. We did not do so, for what we observed was the complete disappearance of the starch grains when illuminated with polarised light, slight serration only occurring in heterogeneous light. Further, after complete hydrolysis of the starch grains by polarised light, the solution deposited crystals which reduced Fehling's solution.

If Prof. Jones is correct in saying that the serration of the starch grains may be caused by other influences, he removes the last difficulty from our minds, namely, the slight change we observed with heterogeneous light. This may now be attributed to those secondary effects and not to incipient hydrolysis.

As the principal cause of these secondary effects Prof. Jones cites the pressure of the cover slide, but this naturally cannot account for the disappearance of the starch grains and their conversion into crystalline compounds which reduce Fehling's solution.

If any doubt remains on this point, we are now able to say that when starch grains in pure water are placed in a Petrie dish or in a flask and illuminated with a strong beam of polarised light, they are hydrolysed. The breaking down of the grains is obvious when they are examined microscopically, and the aqueous film on evaporation deposits crystals which have been found to reduce Fehling's solution.

Although in our paper we refrained from entering into the theoretical explanation of the phenomenon, it is obvious that it must be connected with a selective absorption of polarised radiant energy by the optically active starch grains. In this connexion, the observations made by Liebig and Rubens of the different absorptive power for polarised and ordinary infra-red radiation of optically active crystals are of great significance (*Berl. Ber.*, 1919, 198 and 876).

Prof. Jones makes no mention of other observations which confirm our results. These observations may be divided into two classes, namely, those which had been made previously to the publication of our paper and may be explained by our results; and those observations which have been definitely undertaken as the result of our work. Amongst the first group we may quote the work which was carried out by Knauthe on the influence of moonlight on the photosynthetic processes of certain plankton. His results are quoted at length by Kofoid (*Bull. Illinois State Labs. Nat. History*, 8, 395, 1908). Knauthe found that the relative efficiency of moonlight and sunlight was about 2:9, and Kofoid considers this ratio to be smaller than the maximum and above the average. The relative intensities of sunlight and moonlight were given by Zollner as 618,000:1, and it would seem, therefore, that for equal intensities moonlight is more than

100,000 times as efficient as sunlight. Kofoid followed up this work and established an undoubted correlation between the maxima in the seasonal variation of these micro-organisms and the period of the full moon. This phenomenon may well find an explanation in the fact that moonlight is on the average polarised to the extent of 10 per cent.

As a second example of the well-known influence of polarised light we may mention the peculiarly bad effect on the eyes of the light scattered from a snow field, a phenomenon which is painfully familiar to mountaineers. The high polarisation of such light is well known.

We may also refer to Padoa's observation that crystals of *o*-nitrobenzaldehyde are selectively decomposed by polarised light, provided that the crystals are correctly oriented to the plane of polarisation (*Atti R. Accad. Lincei*, 28, 372, 1919). Other similar phenomena are probably too well known to need mention, such for example as Weigert's observations of the effect of polarised light on the photographic plate.

Of the second group we may quote Morrison's proof of the selective action of polarised light on the growth of luminous bacteria, *e.g.* *Photobacterium phosphorescens* (*Science*, 61, 392, 1925), an observation which has been confirmed by Macht and Hill of the Johns Hopkins University with *B. coli* and *B. typhosus* (*Proc. Soc. Exp. Biol. and Medicine*, 22, 474, 1925). Mention may also be made of Bryant's observation that the polarised light from the moon has a selective action in causing the putrefaction of pieces of fish (*J. Chem. Ind.*, 42, 681, 1924).

Then, again, we may mention the observation by Macht and Hill that the hydrolysis and fermentation of cane sugar by *Saccharomyces cerevisiae* is selectively promoted by polarised light (*Proc. Soc. Exp. Biol. and Medicine*, 22, 474, 1925), and lastly, we have Macht's direct confirmation of our own work (*ibid.* p. 473). In the latter experiments, starch solutions containing definite quantities of taka-diastase were exposed to polarised and non-polarised light. The conversion of the starch into sugar took place more rapidly in polarised light than in non-polarised light of the same intensity, and, as Dr. Macht says, the results he obtained fully corroborate our observations.

Prof. Jones says that he has been unable to repeat our observations, and describes his method of observation with a pointlite lamp. We would suggest that the presence of gelatine in his experiments is very undesirable. If we are correct in our assumption that the phenomenon is due to the selective absorption of polarised radiation, then no other inert colloid must be present, as such may completely interfere with the progress of the particular phenomenon to be observed. If an inert colloid be added, then care must be taken that it does not protect the starch by having the same absorptive power towards radiant energy, and further, that it scatters and polarises radiant energy of the correct wave-length. In short, the extraneous colloid, if it is not in correct tune with the starch and its own particular enzyme, will act as a negative catalyst of the reaction. These correct conditions are undoubtedly secured in the natural enzyme, and it is very questionable whether an entirely foreign colloid such as gelatine conforms to these conditions. This most probably accounts for Prof. Jones's negative results, especially in view of the confirmatory evidence we have previously mentioned.

E. C. C. BALY.

ELIZABETH SIDNEY SEMMENS.

The University, Liverpool, and
Bedford College, London,
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