XIV. THE ACCELERATION OF THE CLEAVAGE RATE OF HAMINEA VIRESCENS

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Cell division is controlled by factors which are not clearly understood, nor is it to be expected that they will easily be explained because of the great complexity of the processss involved in mitosis. One method of analysing the phenomena is that of modifying the process by various means. The present paper is an account of attempts to modify the rate of cleavage in the eggs of the gasteropod, *Haminea*.

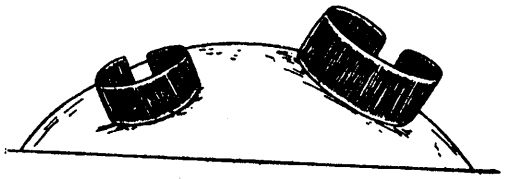
There are many factors known which act to retard cell division in tissues of many kinds. Indeed one of the immediate effects

EXPLANATION OF PLATE II.

FIG. 1. Egg masses of *Haminea virescens*, showing method of attachment to rocks. About natural size.

FIG. 2. The arrangement of the spiral loops of a small portion of the egg case.

FIG. 3. The ends of two loops showing the details of the arrangement of the double rows of eggs. Each egg surrounded by a gelatinous covering.



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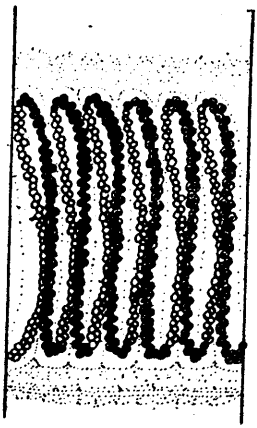

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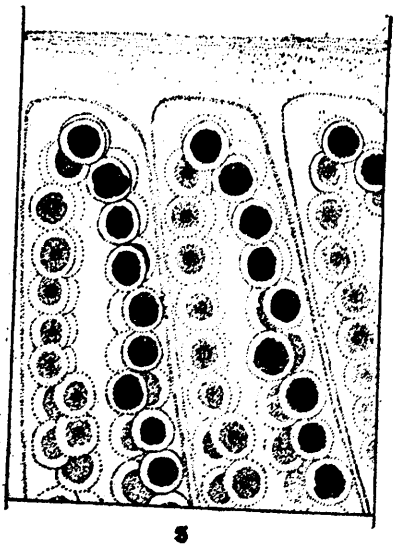

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of any harmful agency is to depress the rate of development. But in many of these cases the effect is doubtless upon the entire organism rather than upon the mitotic mechanism, so they do not give much insight into the nature of the processes.

A more productive means of analysis of the mechanism comes from the study of the agencies which may be used to accelerate the division rate, for these agencies must operate upon the mechanism of mitosis itself.

Although the problems of growth have long been studied, not many agencies have been found which will shorten the time of mitosis. The list of which the writer has found published record is as follows: heat, x-rays, radium, thyroid secretion, supra-renal extract, alcohol, dibasic potassium phosphate, potassium sulphate, potassium bromide, oxygen, sodium hydroxide, and pilocarpine hydrochlorate. Of these, x-rays, radium, and thyroid are the most marked in their effects. All of these agencis are able more or less effectively to increase the rate of cell division. In those cases where the effect is slight, the results are still significant because they are constant. The careful analysis of any constant increase in the rate of division should throw new light upon the forces by which the divisions are produced.

Expirements

During the summer of 1921 while working at the Laboratory of the Scripps Institution for Biological Research at La Jolla, California, the writer attempted to verify some of the agencies listed above and to extend the investigation to others. For this purpose the eggs of the gasteropod, *Haminea virescens* (Sby) were used. These eggs as the writer has shown in another paper, are especially useful for experiments in which the effect of a particular reagent is sought while the environment of the developing egg is partically unchanged except in regard to the factor in question. They are laid in a complicated manner in a jelly-like ribbon in which all are in the same stage of development. This makes is possible to cut up the ribbon into strips using one for a control and others for experiments as seems desirable. One has merely to place some of the pieces in sea water for a control and others in sea water containing the reagent whose properties are being investigated, to have a complete experiment.

The first experiments were with sodium hydroxide following Loeb's observations on *Arbacia*. *Haminea* eggs are slightly accelerated in cleavage by solutions containing .004% to .009% NaOH. But the accelerations of cleavage does not always result in the earlier hatching of the experimental eggs, for in some cases the

advantage gained is expressed in the greater vigor of the larvae rather than in earlier hatching.

The effect of ammonium hydroxide in strength of .006% to .003% was likewise accelerative.

Potassium hydroxide causes acceleration of the cleavage rate only in stronger concentration than sodium hydroxide, .006% to .017% being the range necessary. Neither barium hydroxide nor chromium hydroxide were found to have accelerating effects.

Thyroid extract was found slightly to increase the cleavage rate, but the experiments were not satisfactory in this case, so a more definite statement cannot now be made.

Philocarpine hydrochlorate in weak solutions produced an effect which was in proportion to the concentration within the range of acceleration.

It is suggested from these experiments that probably hydroxides which are of elements belonging to the first group of the periodic series, when used in extremely weak solutions have the property of accelerating cleavage, while those of other groups of the series do not possess this power.

The writer is of the opinion that all of the agencies which may be used to accelerate the division rate, produce their effects by activating intracellular enzymes, the activity of which controls the rate of progress of the mitotic processes.

The data on the experiments reported here will be published in the Biological Bulletin for July, 1922.