PRELIMINARY NOTE ON THE NUCLEAR DIVISION IN THE ADIPOSE CELLS OF INSECTS

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ELEVEN FIGURES

As to the biological significance of amitosis, Flemming's ('91) theory that "it represents either degeneration or an aberration, or perhaps in many cases is tributary to metabolism through the increase of nuclear surface" (Wilson, '00, p. 117) is generally regarded as representing the truth. Cells which have divided amitotically and are active in their metabolic processes may eventually degenerate and perish. This, however, is no direct proof of the first part of Flemming's statements here cited.

My study on the relation of nuclear divisions and metabolic activity in the adipose cells of various insects furnishes good evidence to show that amitosis does not mean the approach of degeneration, or aberration at all, but this kind of nuclear division may be chiefly, if not entirely, to secure the increase of the nuclear surface to meet the physiological necessity which is due to active metabolic interchanges between nucleus and cytoplasm. This is the theory first suggested by Chun more than twenty-five years ago ('90), when he studied amitotic nuclear division in a giant entodermic cell of the radial canal of Siphonophores (Flemming, '91, '92; Wilson, '00), but was somewhat neglected by subsequent writers. According to this theory, amitosis is primarily concerned with the vegetative function of individual cells, and so amitosis can no longer be regarded as one of the two essential methods of cell-multiplication. It may perhaps be considered in association with such phenomenon as the ramification of the nucleus with its increasing functional activity, as in the case of silk-gland cells of many insects, and the division of

the cell-body following that of nucleus is a relatively subordinate phenomenon.

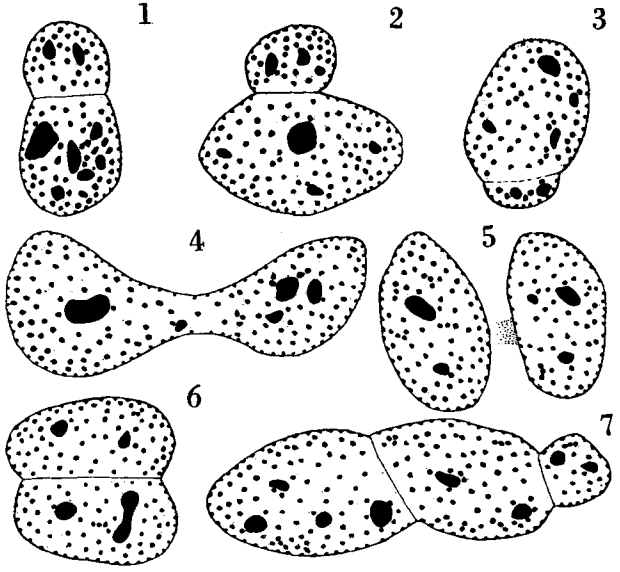
In this paper I wish to point out that in the case of the adipose cells of insects, amitotic nuclear division occurs preparatory to as well as simultaneously with a certain metabolic activity of the cell, in which nuclei take the role of essential importance. Fuller accounts of the relation of nuclear division and the metabolism of the cell in question, together with more extensive discussion on the general subject of amitosis, will be given in my further paper.

The following observation done primarily on larvae of Pieris rapae, brings out the general feature of the changes observable in larval adipose cells during their activity. Changes similar to those described below, have been observed by many previous writers and also by myself in the case of various other insects.

In an adipose cell from a larva of the first stage the nucleus is round and shows no sign of division; the cytoplasmic area is small in most cells and contains only a few vacuoles. These vacuoles we interpret as indicating the places occupied by fat-droplets. This rather unspecialized condition of the cell changes in the following stage by areal expansion and more vacuolate appearance of the cell-body and by frequent occurrence of peculiarly shaped nuclei. Some few of these nuclei show nothing but their irregularity in shape, while most of the others apparently represent different stages in the process of amitosis.

I have shown in figures 1 to 7 sketches of nuclei, all representing possible stages of amitosis, and many of which one can find in every section. I have not been able to find any particular way in which these nuclei divide, except that the division itself is effected by the constriction of the nucleus across its longitudinal axis, thus making the nucleus show a bilobed condition. More rarely, in the case of long, slender nucleus, constriction may take place at more than two different places in the nucleus, and in that case the latter shows multilobed appearance. Nucleoli and chromatin granules are apparently evenly distributed throughout the nucleus, and neither of them seems to behave unusually during the process.

In the third stage larva, one may notice the fact that some of the cells begin to show peculiar spherical granules in the cell-body. As pointed out by Berlese ('99), Pérez ('02, '10), Henneguy ('04), and others, these granules are of albuminous nature, and occur more abundantly in close proximity to nucleus, than in the periphery of the cell. They become very abundant at the fourth stage and at the last larval stage almost all of the adipose cells are seen to be filled with the granules. The cell-



Figs. 1 to 7 Nuclei of adipose cells, representing possible stages of amitosis. × 750. Figure 6 represents predominating type.

body becomes larger and larger with the advancing stages of the insect; apparently correlating with this, the occurrence of nuclear division is seen more and more frequently, and finally, in old larvae, we find the condition as shown in figure 8 to be met with very commonly.

Summarizing the facts, we may say that, in the adipose cell, the nucleus continues to divide amitotically from early in the second stage, and the cell stores up albuminous granules in its cell-body, commencing the process late in the third stage. This

shows that the cell-nuclei which have undergone amitotic division, without regard to whether the cells remain multinucleate or not, do not degenerate, and the cells proceed with their active functional processes. This can be more strongly emphasized because we now see the fact that nuclei themselves take a direct part in the formation of albuminous granules, giving most conclusive evidence in support of the theory.

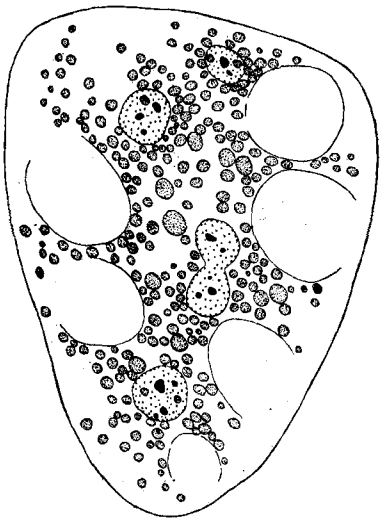
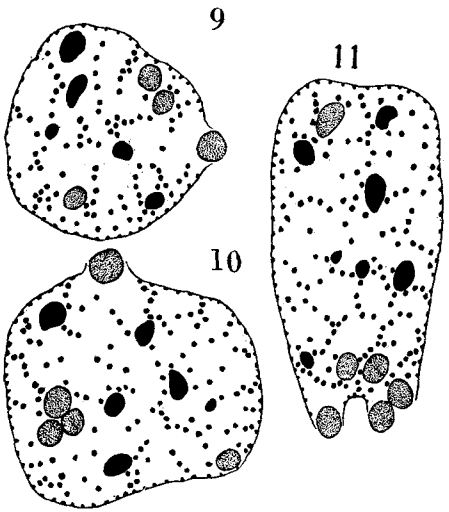


Fig. 8 A multinucleate adipose cell from an old larva, containing albuminous granules in its cell-body. × 250.

It has been supposed by some writers that albuminous granules are derived from the blood. Hollande's ('14) recent work, from the chemical viewpoint, casts grave doubt on this assumption, and although he has given no evidence, he has suggested that the granules may be of nuclear origin. It seems quite probable, from a cytological point of view, that such might really be the case, and especially so when we recall the fact that, in the case of silk gland cells of Pieris and Neuronia at least, the nucleoli, after eliminating their phosphorus, change into albuminous granules and then extrude bodily out of the nucleus (Nakahara, '17).

Examining the nuclei of such cells as contain the granules, one can distinguish three different kinds of granules within them. One of the three kinds undoubtedly represents chromatin and another nucleoli, as can be judged from their appearances and staining reactions, characteristic of such elements. The third kind of granule is of nearly the same size as nucleoli but differs from the latter in that it shows stronger affinity for certain acid



Figs. 9 to 11 Nuclei of adipose cells, showing the extrusion of acidophile granules. × 750.

and weaker for basis stains. This is exactly the sort of reaction shown by the cytoplasmic albuminous granules, and one may here assume that these acidophile granules in the nucleus may be extruded into the cell-body, constituting the albuminous granules in question. As evidence in support of this theory, I have shown in figures 9 to 11 some unmistakable cases of extrusion of the acidophile granules into the cell-body through the nuclear membrane. These are not cases rarely observable but are those of very frequent occurrence.

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