Plastids.

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(Abstract)

The major part of the results of an extended study on plastids and similar bodies in cells of various plants, of which the following is an abstract, has been published in the Annals of Botany, Vol. 32, pp. 91-114, 1918.

The investigation was concerned chiefly with the origin of leucoplasts and chloroplasts from their primordia, as found in meristematic cells. The primordia of leucoplasts and chloroplasts appear as very minute, granular or rod-shaped bodies, which multiply by direct division. From such primordia, leucoplasts develop as rounded or pear-shaped bodies with the starch inclusion accumulating within. In case the primordium is rod-shaped, the leucoplasts, in such tissues as the root tip of *Pisum*, take on the form of a hand mirror with the inclusion in the larger end.

In certain typical cases the primordium of the chloroplast may first become lenticular with a pale center and a densely-staining periphery. With further growth they finally assume the form present in the adult plant organ.

Morphologically the primordia of leucoplasts and chloroplasts are precisely alike. It may be of interest to note that the morphological identity of leucoplasts and chloroplasts was pointed out by A. F. W. Schimper about thirty-eight years ago. The following is a translation of his summary (Bot. Zeit., p. 899, 1880): "The results of this brief study show that the deep chasm hitherto supposed to exist between the starch formers in assimilating and in non-assimilating cells does not, in fact, exist. In cells free from chlorophyll there are definite organs which generate starch, and these organs are none other than undeveloped chloroplasts (Chlorophyllkörner), which under the influence of light are able to develop into the latter. On the other hand, chlorophyll grains are not always organs of assimilation merely, but they may, in the conducting tissues and in cells which contain reserve material, function as starch

formers in the non-assimilating cells; they produce starch from assimilated materials supplied by other parts of the plant."

It may be stated also that the origin and formation of starch grains as described by this brilliant Alsatian was essentially correct, as later studies of others have shown. At that date the technique which now so clearly brings out the primordia of plastids was unknown.

In the aleurone layer of the endosperm of *Zea Mays*, the primordia of the aleurone grains are first recognized as very minute, rounded granules which may stain densely and uniformly. As they increase in size, they become globular with a smooth and sharply-defined contour and reveal a pale or colorless center. They may be represented by making a minute circle with a pencil. As they become older, they increase in size and usually take on a pale yellowish or orange color with the stains used.

It may be remarked also that the starch grains in the endosperm of *Zea* originate in a similar manner and from primordia that are indistinguishable morphologically from those of the aleurone granules, with the difference that in the case of the leucoplasts the starch inclusion stains blue with gentian violet.

In addition to the primordia of the plastids mentioned, other similar though smaller bodies are present—frequently in very large numbers in the cells—which do not become either leucoplasts or chloroplasts. To these I have confined the term *chondriosome*. Such chondriosomes are especially well demonstrated in cells of the liverworts, *Anthoceros* and *Marchantia*.

The conclusion reached is that the primordia of leucoplasts and chloroplasts and the bodies here designated as chondriosomes are permanent organs of the cell, having the same morphological rank as the nucleus.

The function of chondriosomes is not known. It is generally conceded that they are concerned in certain metabolic activities of the cell. Being definite organs of the cell, they may be regarded also as playing some part in the rôle of heredity.