Two Forms of Division Profile in Spinach Chloroplasts

CHLOROPLAST division is generally thought to take place by constriction (fission)¹⁻⁷. Division may also occasionally occur by the growth of a central baffle before separation⁸⁻¹¹. Usually only one type has been observed for a given tissue although searches have been made for the alternative form. The present communication, forming part of a study on the effect of light and dark treatments on cultured leaf disks, describes the ultrastructure of spinach chloroplasts which exhibit both dumb-bell and central baffle profiles suggestive of division.

the two forms are intimately related, the baffle forming subsequent to invagination and rupture of the thylakoids. In the case of spinach this does not seem a likely explanation as partial baffles with intact thylakoids beneath have been seen (Fig. 3). The presence of fission profiles in which unbroken thylakoids pass across a narrow isthmus also argues against this explanation.

If this type of plastid represents a form of division it is clear that the two types can occur within a small area of a leaf. It would seem likely that physical disjunction of plastids possessing a baffle could occur by the rupture of the outer membrane of the envelope with its concomitant synthesis. It has been observed that the thylakoids of such plastids are swollen and

Fig. 1 Fission profile of chloroplast from base of 2 cm long leaf ($\times 19,200$).

Fig. 2 Chloroplast segregated into two regions by a baffle (b). The outer membrane of the envelope is intact (arrow) ($\times 14,400$).

Fig. 3 Incomplete baffle (b) ($\times 12,600$).

Fig. 4 Breakage of outer membrane of chloroplast envelope (arrow) opposite the baffle ($\times 19,800$).

Disks (1 mm) from the base of 2 cm long leaves were cultured on a medium similar to that used for whole plants¹², but containing 0.5% sucrose and solidified with 0.9% agar. After 24 h darkness, the disks were removed and fixed in 6.25% glutaraldehyde in 0.1 M phosphate buffer (pH 7.2) and postfixed in 2% OsO₄.

Many cases of fission profiles such as have been reported previously¹⁻⁷ have been seen in this tissue (Fig. 1). Chloroplasts with invaginations of the inner membrane of the envelope have also been observed, and occasionally these are asymmetric, cutting off only a small region of stroma. Their function is unknown. More generally, however, the intrusion segregates the plastid into two equal zones (Fig. 2). Serial sections suggest the membranes form a baffle extending across the entire lumen of the organelle. Occasional profiles in which the baffle extends across only part of the stroma have also been observed (Fig. 3). In addition, plastids with the outer membrane of the envelope ruptured at points opposite where the baffle joins the inner membrane have been noted (Fig. 4).

Only Diers¹¹ and Mühlethaler⁸ reported the presence of both fission and baffle profiles in the same tissue. The plastids observed by Diers were proplastids and those observed by Mühlethaler were chloroplasts. Mühlethaler⁸ suggests that

that, in general, the surrounding cytoplasm is more disperse than in cells in which the classical form of division profile occurs. It is possible that the physiological state of the cells in which the two types occur differs.

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