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Short Communication

Plastid Fusion as an Agent to Arrest Sorting Out

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Summary. Plastid fusions were noted in an ultrastrucutal study of a mutant of *Hosta* showing slow sorting out of plastid genes. These data suggest that fusions between wild type and mutant plastids might increase the mixing of plastid DNA and hence slow the process of sorting out. It is likely that peripheral reticula are involved in the process of plastid fusion between the mutant and wild-type plastids.

Key words: Plastid fusion – Sorting out – Plastome – Mixed cells

Introduction

Vegetative segregation of genetically dissimilar plastids or mitochondria into pure cell lines is characteristic of virtually all organelle genetic systems studied (Birky 1978; Gillham 1978; Sears 1980). The process of sorting-out is generally so rapid that mixed cells are rarely observable after several cell generations. Exceptions to the rapid sorting out of plastids have been reported in several higher plants (Ueda and Wada 1959) although the only exception to be investigated genetically is that found in *Hosta*, described by Vaughn and Wilson (1980a).

How could a plastid resist sorting out all of these cell generations? One possible mechanism, plastid fusions such as those described by Cavalier-Smith (1970) and Gillham (1978) in *Chlamydomonas* and by Esau (1972) in *Mimosa*, would allow for a continued mixing of plastid DNA so that it might be possible for mixed cells to be retained for over 50 years, as is the case for the *Hosta* mutant (Yasui 1929; Vaughn and Wilson 1980a).

Because the ultrastructure of the wild type and photobleaching mutant plastids of *Hosta* are well established (Vaughn et al. 1980a; Vaughn and Wilson 1980a, b), plastid fusions between these two diverse types can be distinguished from plastid division. A similar approach was used by Boynton (in Gillham 1978) to distinguish mutant mt^+ and wild type mt^- plastids in *Chlamydomonas*. In this report we describe apparent plastid fusions between wild type and mutant plastids of seedlings from *Hosta* 'Vaughn 73-2' that could explain the persistence of mixed cells in this plant.

Materials and Methods

Small pieces of tissue from leaf areas of *Hosta* 'Vaughn 73-2' showing sorting out variegation were fixed for electron microscopy according to Vaughn et al. (1980a) and observed with a Hitachi HU 11-C electron microscope.

Results and Discussion

Figures 1 and 2 show apparent plastid fusions in progress between mutant and wild type plastids of *Hosta* 'Vaughn 73-2'. Serial sections of these plastids show that these are two distinct plastids and not parts of a single abnormal mutant plastid. Mutant plastids contain distinctly vacuolated thylakoids, characteristic of this strain (Vaughn and Wilson 1980a), with the shade-type wild-type plastids containing a normal thylakoid system (Fig. 1, 2). Similar plastid associations or fusions were observed in other sections, although not all were analyzed by serial sections as has been done for the fusions in the figures. Extensive fusions appear to take place along the mutant plastid near areas of peripheral reticula, areas of extensive development of the plastid inner envelope (Vaughn et al. 1980a, b; Vaughn and Wilson 1980b).

Persistent mixed cells have been noted in *Tradescantia* (Keresztes 1971), *Chlorophytum*, *Hosta*, and *Hemero-*

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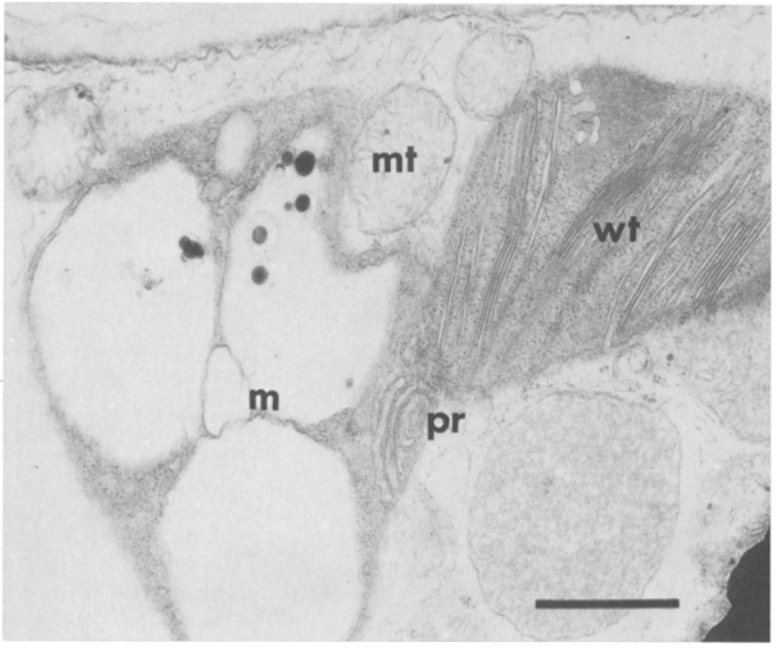

Fig. 1. Apparent plastid fusion between a mutant (*m*) and wild-type (*wt*) chloroplast along the chloroplast envelope. Note involvement of peripheral reticula (*pr*) in the fusion and association of mitochondria (*mt*) with both wild type and mutant plastids. Bar = 1 μm

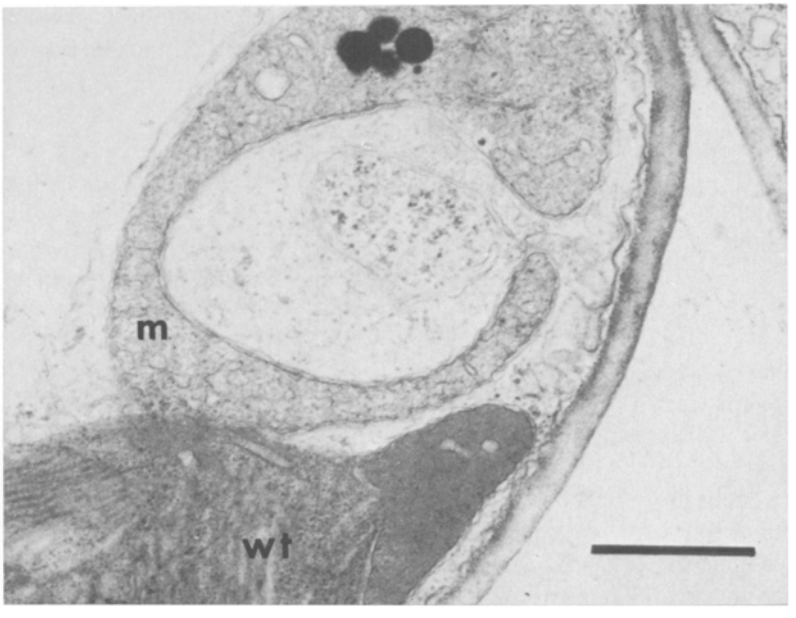

Fig. 2. Plastid fusion similar to that observed in Fig. 1. Labelling as in Fig. 1. Bar = 1 μm

callis (Ueda and Wada 1959). Although the *Hemerocallis* has not been investigated ultrastructurally, the other species with persistent mixed cells all have magnograna type ultrastructure and extensive amounts of peripheral reticula (Gyurjan et al. 1977; Vaughn et al. 1980a, b; Vaughn and Wilson 1980a, b). Because peripheral reticula effectively increase the inner envelope area (Spey and Laetsch 1978) and this appear to be the area of contact in the plastid fusions in the *Hosta* mutant, such areas may allow for plastid fusion and a subsequent exchange of the genetic material between wild type and mutant plastids. Similarly, Esau (1972) has shown that in *Mimosa pudica* chloroplast fusions nearly always involved the peripheral reticulum system, which was well developed in this species. These data further substantiate the role of peripheral reticulum in plastid fusions, because the fusions are observed most commonly in strains with this plastid structure.

Our original conclusions (Vaughn and Wilson 1980a) on the nature of the *Hosta* mutant still hold true: the mutation is maternally inherited and the mutation appears to be dominant to the wild type so that within-plastid sorting out of wild type and mutant plastid DNA continues to give rise to new mixed cells. A second force, however, that of plastid fusions (perhaps mediated by the peripheral reticulum), may enable the plastids to remain heterozygous for many more cell generations than is normally noted.

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