ABSTRACT

COORDINATION OF DIVISION COMPLEXES ACROSS THE PLASTID ENVELOPE MEMBRANES

By

Jonathan Matthew Glynn

Chloroplasts are cellular organelles descended from a cyanobacterial endosymbiont and house the photochemical machinery which powers synthesis of reduced carbon compounds from carbon dioxide and water. In higher plants, the chloroplast is also the site of synthesis for a select group of lipids, amino acids, and plant hormones. This set of organelle-specific functions make the chloroplast essential to survival of land plants, the most prominent group of terrestrial primary producers. The replication and segregation of plastids within land plants occurs through binary fission and is an important part of plant cell biology, as chloroplast size and number may impact the efficiency of photosynthesis and the partitioning of chloroplasts to daughter cells during plant cell division.

The apparatus that facilitates the scission of a single chloroplast into two daughter chloroplasts is a complex macromolecular machine, partly composed of a host-derived dynamin ring on the outside of the organelle and an endosymbiont-derived FtsZ ring (Zring) inside the organelle. The activities of these two rings must be tightly coordinated across the two envelope membranes of the chloroplast to ensure the timely progression and completion of division.

Here, I show that ARC6, a known FtsZ assembly factor that promotes formation of FtsZ filaments, also specifies the mid-plastid positioning of the paralogous outer

envelope proteins PDV1 and PDV2, which have parallel functions in dynamin recruitment. PDV2 positioning requires a direct interaction between ARC6 and PDV2 that may be regulated by post-translational modification of ARC6 within the intermembrane space. I also show that PARC6 (Paralog of ARC6), like ARC6, is a multifunctional inner envelope chloroplast division protein. PARC6 acts downstream of ARC6 to position PDV1 at the division site, but is not required for PDV2 or ARC5 localization. Arabidopsisparc6 mutants exhibit compound chloroplast division phenotypes and FtsZ filament morphology defects suggesting that PARC6 acts antagonistically to ARC6 within the chloroplast stroma as an inhibitor of FtsZ assembly. This FtsZ assembly-inhibiting activity of PARC6 may occur through interaction with ARC3, a protein with functional similarity to bacterial MinC. PARC6-GFP localization is dynamic, consistent with its complex role in division. Our findings indicate that PARC6 and ARC6 play related but distinct roles in coordinating the internal and external components of the chloroplast division complex.