

## Formation of plastid tubules in CAM-performing species

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Formation of tubular inclusion bodies have been noticed from immature and young leaves of *Sedum* and *Orostachys* species, while investigating developmental changes of plastid ultrastructure in Crassulacean acid metabolism (CAM) performing species. Well-defined tubular structures, but not bounded by a membrane, were formed in almost all of the mesophyll cell plastids. The plastids also included prolamellar body, abundant starch grains, little plastoglobuli, and rudimentary thylakoids. One of the most interesting features on the structure was the size and their distinct arrangement. The shape of plastids varied considerably by the presence and size of the tubular inclusions and starch grains, especially in *Sedum* species. A large inclusion extended through the stroma, sometimes from one side to the other of the plastid. Paracrystalline inclusions as a huge aggregate consisting of several thousands of tubular elements were also often detected. The diameter of tubular elements were found to be approximately 25 nm and appeared to be surrounded by several subunits. The tubular inclusions have been considered as microtubules due to their structural attributes. The most attractive hypothesis for the role of this structure within plastids is that the inclusion body stores enzymes necessary for the operation of CAM photosynthetic pathway.

*Key Words:* Plastid tubular inclusions, leaves, *Orostachys*, *Sedum*, CAM