Crystals of desmids

A fascinating trait of Desmidiales is their formation of crystals. They accumulate barium, forming barium sulfate crystals (barite) as well as storing strontium in different ways (Brook *et al.* 1988, Niedermeier *et al.* 2018). This is particularly evident in the genus *Closterium* which has a terminal vacuole on each semi-cell that stores barite crystals (figure 1). These crystals can be seen shaking and moving around in the terminal vacuole (Brook *et al.* 1988). In the genus *Microsterias,* barite crystals can be found throughout the cell (figure 2) (Niedermeier *et al.* 2018).

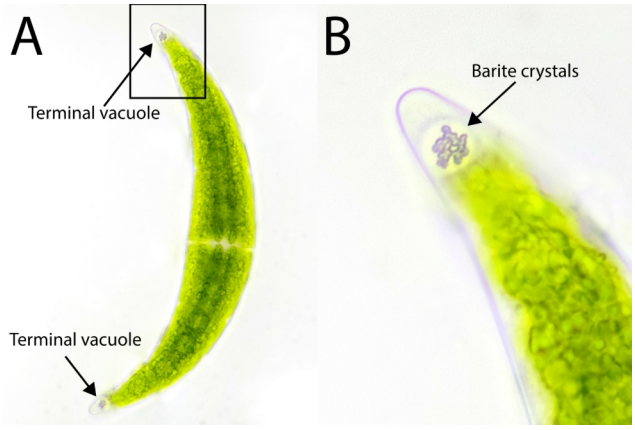

Figure 1. Brightfield image of *Closterium sp.* (A) shows the hole cell with terminal vacuoles at either end. (B) show magnificartion of (A) where barite crystals are visible in the terminal vacuole (Falck).

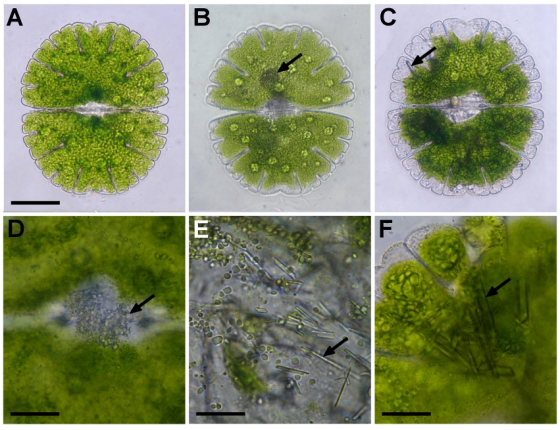

Figure 2. Brightfield images of *Micrasterias denticulata.* Crystalls indicated by balck arrows. Scale bars (A-C) = 50 µm and (D–F) = 20 µm (Niedermeier *et al.* 2018).

Levels of barium in the water affect the amount of stored Ba in the cells of *Closterium*. At low concentrations they do not form barite crystals, yet still manage to survive. This means that the crystals are not a vital component of the cells. At high concentrations of Ba, they also form barite crystals outside of the terminal vacuoles (Brook *et al.* 1988, Krejci *et al.* 2011).

When strontium concentration in the water becomes high, strontium gets incorporated in the crystals of *Closterium* making $(Br,Sr)SO_4$ (Wilcock *et al.* 1989, Krejci *et al.* 2011). This effect has been discussed as a potential way to clean up radioactive ^{90}Sr from the environment (Krejci *et al.* 2011). Niedermeier *et al.* (2018) showed that *Microsterias* as well as forming barite also form strontium citrate crystals. They also showed that the crystals were always compartmentalized away from the cytoplasm either in vacuoles or between the cell wall and the cell membrane. Desmids are however not immune to the effects of high levels of Ba and Sr. At a significant concentration of $BaCl_2$ and Cl_2Sr, respectively in the water, cell division rates were lower than usual (Niedermeier *et al.* 2018).

The function of these crystals has been enigmatic. Several hypotheses regarding the biological function of these barite crystals have been discussed. One old theory is that they are for gravity sensing similar to statoliths (Brook *et al.* 1988). However, Niedermeier *et al.* (2018) argue that the function is detoxification, due to crystals never being stored in the cytoplasm where the metals would be harmful. They also strengthen this argument with the research done by Andosch *et al.* (2015) that showed that other metals such as Cd and Cr are more harmful because the desmids can not compartmentalize them.

References

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