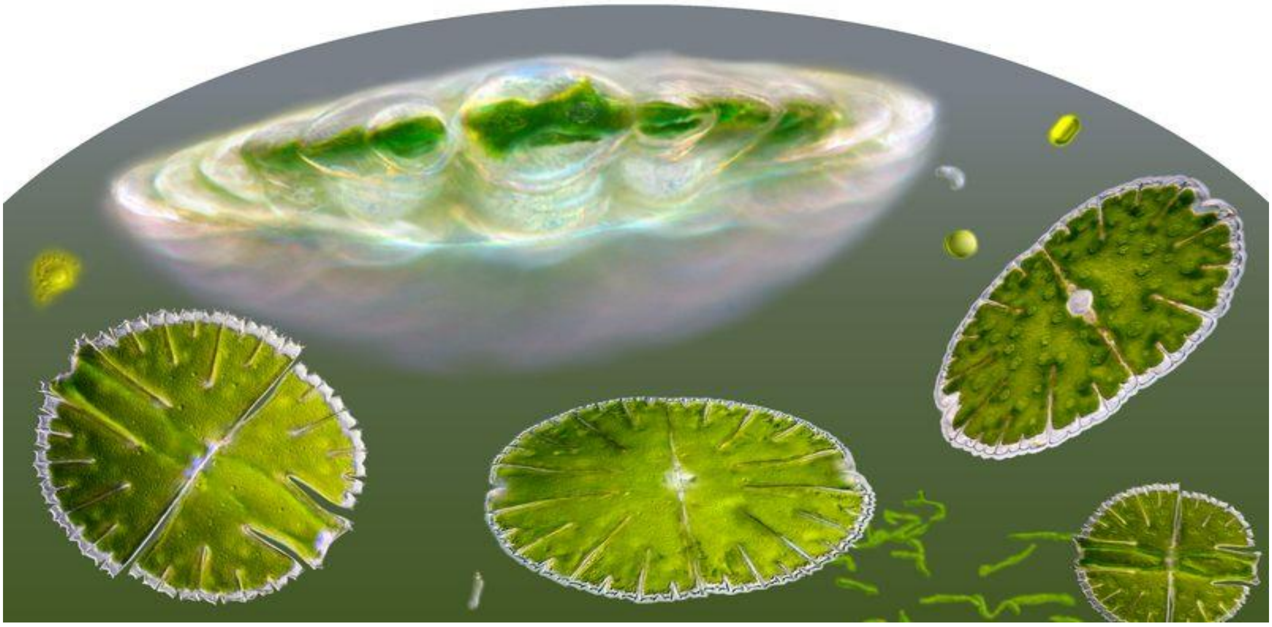

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Micrasterias – Little Stars

Part 1: Taxonomy, mitochondria

The species of the desmid genus *Micrasterias* are well known for their beauty. Their gracefully built cells in symmetry inspire the microscopist again and again anew, and their cell size facilitates the observation even with simpler microscopical equipment. *Micrasterias* means „little star".

The genus occurs worldwide and covers approx. 40 species. They populate oligotrophe, standing water bodies up to acidic and very nutrient-poor biotopes like bogs. These representatives of the unicellular, unflagellated green algae from the group of desmids (Zygnematales / Streptophyta) are built up of large, flattened cells, whose lateral view is fusiform. A central constriction called "sinus" separates them in two halves. The nucleus is situated at the so-called "isthmus", the narrow junction point of the two half-cells. Every half-cell owns its chloroplast with pyrenoids. Symmetrical cuts within the half-cells shape lobes, so the cells appear as small stars. Some species wear prickles on the cell surface.
After collecting the desmids, they are much inured to treatment. It is simple to keep alive these algae in the collecting container without addition of nutrients for a longer period.

Classification

The taxonomic group called desmids is intensively investigated, maybe due to the attractiveness of its members. They occur in many biotopes around the globe and prefer nutrient-poor habitats. There are species, which occur in arctic regions (Lenzenweger und Lütz, 2006; Lenzenweger, 2007), others lives in the tropics (Lenzenweger, 2003). Due to newest investigations from morphology, cytology and gene analyses the genus *Micrasterias* is still assigned to the group of the Desmidiales, which contains approx. 40 genera with overall 4.000 - 6,000 species. Within the superordinate group of the Chlorobionta they are assembled in the clade Phragmoplastophyta combined with the Charophyta and the Parenchymatophyta comprising Choleochaetophyta and Embryophyta, i.e. the higher plants (Lecointre and Le Guyader, 2006).

The taxonomists refer to the term “clade”, if they assume that all group members descend from a common ancestor. The closest relatives of the Zygnematales are the Plasmodesmophyta. During build-up of the separating structure in mitosis called Phragmoplast, it is ensured that cell wall openings remain between the neighbouring cells as communication channels (the so-called plasmodesms).

The group of Plasmodesmophyta unites all genera of higher plants together with Charophyta and Choleochaetophyta. The paleobotanists assume that the higher plants developed before approx. 450 million years on the basis of a common ancestor with the Charophyta. Therefore the Desmidiales are classified as rather close relatives of all higher plants.

Light microscopy studies on *Micrasterias*

Micrasterias rotata is one of the desmid stars concerning elegancy and size (length 200 – 300 µm, width 190 – 270 µm). Since the cell is flat, it is not too difficult to take a photomicrograph exhibiting the outline of the cell together with the chloroplasts and the pyrenoids on them in focus.

Mitochondria

Looking into the microscope at higher magnification (aperture 1.0 and higher) with enhanced contrast (such as DIC), a whole set of structures is distinguishable in the cell plasma. Focussing slowly down, starting on the cell wall towards the chloroplast, scarcely underneath the cell wall an intense flow of tiny cytoplasm particles can be detected. During such an observa-

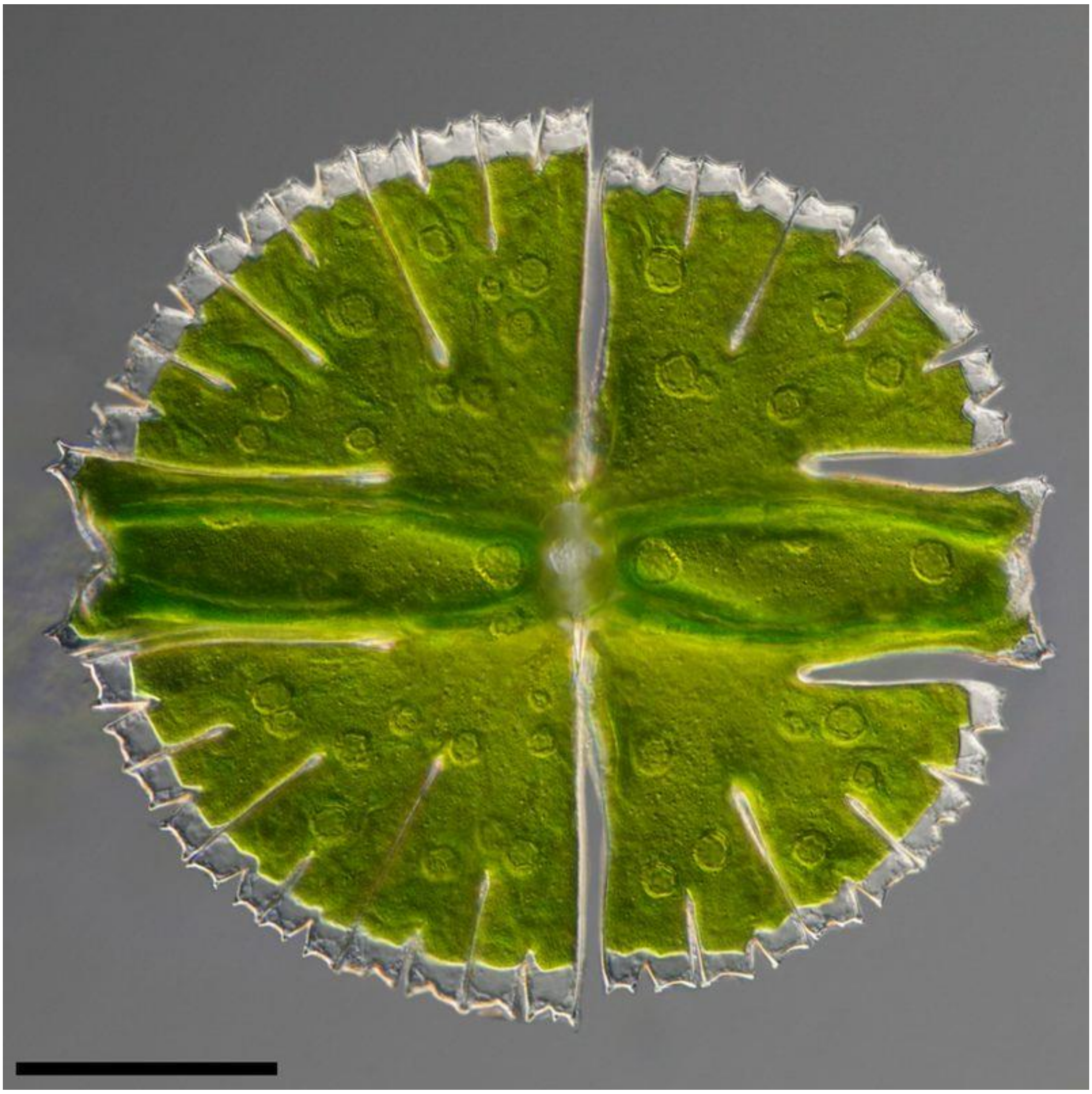

Fig. 3: *Micrasterias rotata* . Picture showing the outline together with the chloroplasts and the pyrenoids on them. Manually stacked using 8 micrograph frames (Zeiss Planapo 40/1.0, DIC). Scale bar indicates 50 µm.

ation I had the ability to differentiate small rigid circular from oblong, form-variable components. The small circular ones with a diameter of app. 0.5 µm were swept away by the current of cytoplasm. On figure 4 they are weakly recognizable as dimmed dots. The oblong parts however oscillated usually around a fixed point such as flags in the wind (see arrow heads on fig. 4 and 5). Besides them again and again high-refractive spheres with diameters over 0.5 µm (probability oil droplet) were visible (arrows on fig. 4).

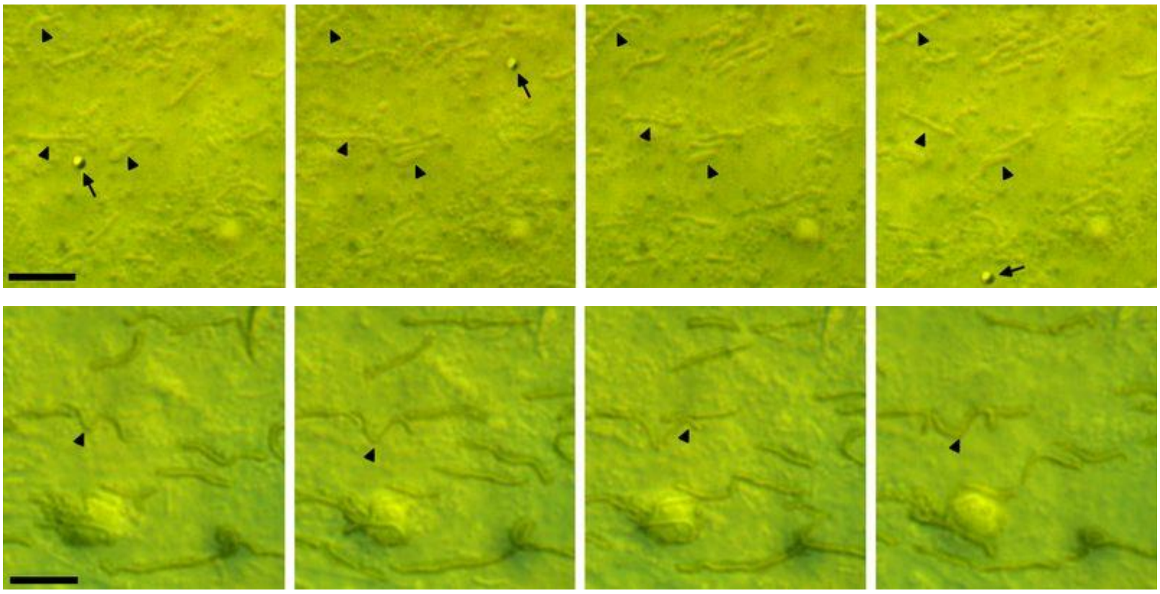

Fig. 4 and 5: Different particle types in the current of cytoplasm of M. rotata. The frames of the photograph series are taken up in the 1-second pulse in each case. Arrows = (probably) spherosomes, arrowheads = mitochondria. For reasons of the clarity the movement stages of some mitochondria were only marked. Scale bar indicates 5 µm.

By comparison with structures, which Drawert and Mix had described in1961 referring to their observations on *M. rotata*, I recognized that the oblong particles were identical to mitochondria. In 1978 Bereiter-Hahn documented similar kinds of shaping and location with mitochondria on endothelium cells of tadpole hearts.

Studies on further *Micrasterias* species

After these discoveries with *M. rotata* I wanted to know whether similar observations would be possible also with other *Micrasterias* species with approximately the same size, for instance *M. denticulata* and *M. apiculata*. With definitely smaller species as for example *M. truncata* the plasmatic current is likewise visible. Using the optical microscope, however, the particles are too small for assigning them unequivocally to the above-mentioned groups.

Micrasterias denticulata (fig. 6) often lives in similar habitats like *M. rotata*, this means acidic or moderate acidic waters of fens, swamp meadows, or pools in bog areas (Lenzenweger, 1996). This is also true for *M. apiculata,* but this species is rather rare.

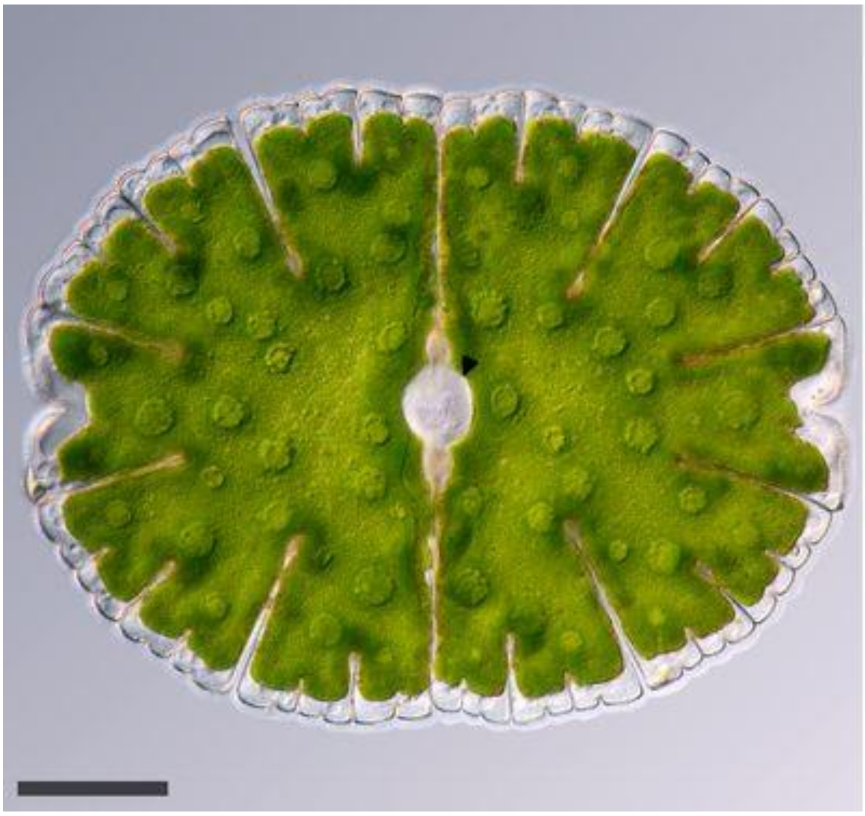

Fig. 6: *Micrasterias denticulata*, showing shape, chloroplasts with pyrenoids plus nucleus. Picture built up using 20 frames, stacked manually. Scale bar indicates 50 µm.

At *M. apiculata* (fig. 7) and *M. denticulata* (fig. 8) just like with *M. rotata*, the mitochondria were permanent in oscillating motion. Whereas at *M. apiculata* the appearance of the mitochondria (size and place for observation) was very similar to them at *M. rotata*, the ones at *M. denticulata* were more voluminous but their number were substantially smaller and they were situated more deeply in the cell in the proximity of the chloroplast.

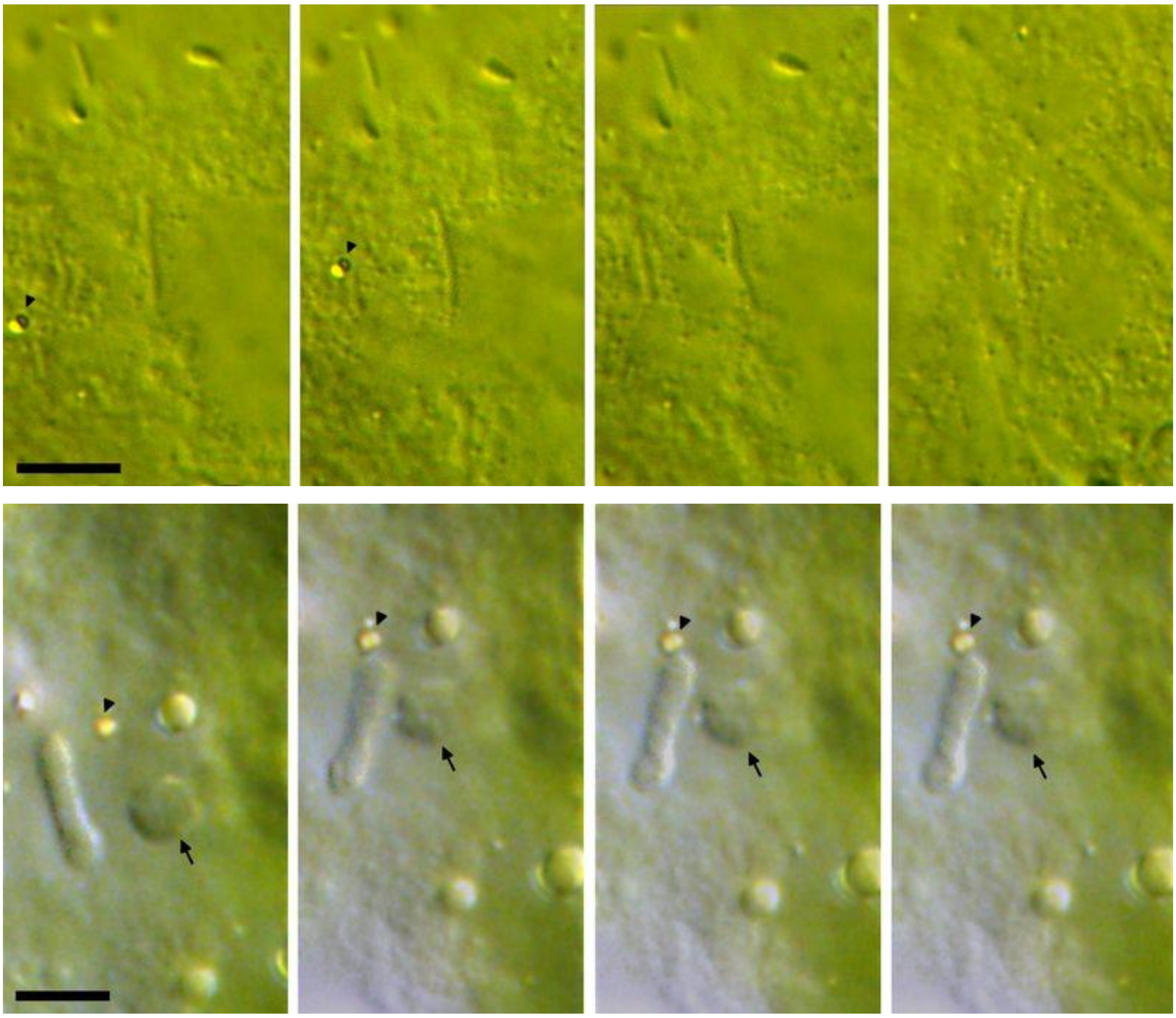

Fig. 7: A series of shots of *M. apiculata* showing a mitochondrion in oscillation together with a spherosome (arrowhead). Fig. 8: A series of shots of *M. denticulata* showing a mitochondrion in oscillation together with a dictyosome (arrow) and a spherosome (arrowhead). Scale bar indicates 5 µm.

According to the widely accepted serial endosymbiosis theory mitochondria originated from aerobic prokaryotes (bacteria). In the course of co-evolution within the eukaryotic cells the cell wall of the former bacteria was lost (Sagan, 1967; Bell, 2001; Plattner und Hentschel, 2006). They still have their own (reduced) genome. Mitochondria are mostly oblong organelles with dimensions of 0.2 – 1 µm cross 2 – 8 µm, which corresponds to the size of most bacteria, and they divide independently. Often they are form-variable and are moved quickly by the cytoplasmic current. The quantity of mitochondria per cell can vary conspicuously from cell type to cell type. Some oocytes contain more than 100,000 mitochondria, the trypanosomes (flagellates; one species is the pathogen of the sleeping sickness) possess only one, which cross nearly the whole cell body and take a relatively considerable volume.

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