Ultrastructural analysis of cell wall formation in the filamentous alga *Desmidium swartzii*

M. Höftberger, and U. Lütz-Meindl

Plant Physiology Division, Cell Biology Departement, University of Salzburg, A-5020 Salzburg, Hellbrunnerstraße 34, Austria

Margit.hoeftberger@sbg.ac.at
Keywords: antibody-labelling, cell wall formation, desmids

Desmids are green algae growing mainly in highmoors under oligotrophic conditions. Most members of this family are single cells and consist of two half cells with a highly symmetric, bizarre shape, that are used as systematical marker. Cell shape formation of this group of algae, already investigated in many studies [1], bases upon biochemical and physical properties of the cell wall.

Unicellular desmids like *Micrasterias* form different types of cell walls during morphogenesis. Development starts with formation of a septum in the isthmus region separating the two half cells from each other. It is followed by primary wall formation, that builds the final shape of the cell by incorporation of wall material in a distinct pattern. Thereafter a rigid secondary wall, with high cellulose content, is deposited. Finally slime is secreted through cell wall pores, which leads to a shedding of the primary wall. Different immunocytochemical and biochemical investigations have shown that pectins with varying degree in esterification, ß-(1-3,1-4) glucans as well as arabinogalactan-like proteins are the main components of the cell wall in *Micrasterias* [2, 3].

Among the few filamentous desmids, which represent links to multi-cellular algae, only *Bambusina* and *Onychenema* are well studied regarding morphogenesis [4, 5]. The filamentary desmid *Desmidium* (Fig. 1) is often found associated with unicellular forms like *Micrasterias.* In contrast to *Micrasterias* cell division of *Desmidium* starts with elongation of the primary wall in the isthmus area, followed by septum formation and thus separation of the semicells (Figs.1, 2).

In a certain distance to the septum rim two cylindrical cell wall rings (Fig. 2) develop perpendicular to the septum at both sides. The septum as well as the cell wall cylinders are underlayed by a secondary wall. Similar to *Bambusina* the final cell shape results from a splitting of the septum and unfolding of the cylinder wall. The splitting of the septum starts at it's outer margin and continues to the outer cell wall cylinder. Here it changes direction and tears apart the primary wall of the cylinder perpendicular to the septum. The cylinder unfolds und thus becomes part of the outer cell wall together with the former septum.

The inner cell wall cylinder as well as the septum lying in between also split off and the cylinder unfolds so that finally the two newly built cells are connected only by the cell wall that lies between inner and outer cylinder (Fig. 2).

Labelling with antibodies at TEM level shows that the secondary wall of *Desmidium* is recognized by BG 1 (Fig. 3) specific for ß-(1-3,1-4) glucans (hemicellulose). The primary wall is stained by JIM 5, an antibody against low methyl-esterified pectins and by JIM 7, an antibody aginst high-methyleserified pectins. The anibody JIM 13, which recognizes arabinogalactans (structure proteins of the cell wall), labels smaller vesicles, parts of the dictyosome and the plasma membrane, especially in non-growing parts of the *Desmidium* cell. The immune cytological studies in *Desmidium* show a similar distribution of epitopes as found in unicellular desmids like *Micrasterias* [2, 3].

Additionally other ultrastructural investigations of *Desmidium* show great similarities to various unicellular desmids, e.g. large dictyosomes, the occurrence of pores in the

M.A. Pabst, G. Zellnig (Eds.): MC2009, Vol. 2: Life Sciences,
DOI: 10.3217/978-3-85125-062-6-224, © Verlag der TU Graz 2009

secondary wall and the presence of cellulose synthase delivering F-vesicles [for comparison see 1].

1. U. Meindl, Microbiol. Rev. **57** (1993) p415-433.
2. M. Eder, U. Lütz-Meindl, J.Microsc. **231** (2008) p201-214.
3. M. Eder et al., J. Phycol. **44** (2008) p1221-1234.
4. J.M. Krupp, N.J. Lang, J. Phycol. **21** (1985) p16-25.
5. J.M. Krupp, N.J. Lang, J. Phycol. **21** (1985) p316-322.
6. The aid of Mag. Ancuela Andosch in cryo-fixation and cryo-substitution is greatfully acknowleged.

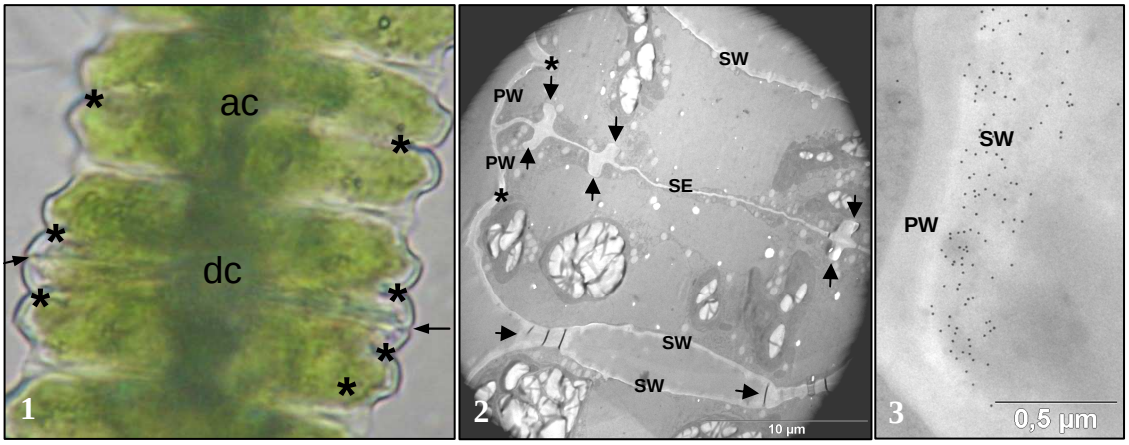

Figure 1. Part of *Desmidium* filament with an adult (ac) and a dividing (dc) cell. Through the newly built primary wall (arrows) in the isthmus (asterisks) the basic cell shape is established.

Figure 2. Ultrastructure of dividing *Desmidium* cells (cross-section). The newly built primary wall (PW) arising from the isthmus (asterisks), and outer and inner cell wall cylinder (vertical arrows) perpendicular to the septum (SE) are visible. The length of the connecting cell wall between two cells (horizontal arrows) corresponds to the area between inner and outer cell wall cylinder. SW (secondary wall).

Figure 3. Newly built primary wall (PW) in the isthmus with adjecent secondary wall (SW). The secondary wall is strongly labelled from BG 1, the primary wall remains unstained.

M.A. Pabst, G. Zellnig (Eds.): MC2009, Vol. 2: Life Sciences,
DOI: 10.3217/978-3-85125-062-6-224, © Verlag der TU Graz 2009