

Molecular regulation of mating in the pennate diatom *Seminavis robusta*

Moeys Sara^{1,2,3}, Jeroen Gillard⁴, Barbara Bouillon^{2,3}, Koen Van den Berge⁵, Marie Huysman^{2,3}, Lieven Clement⁵, Koen Sabbe¹, Lieven De Veylder^{2,3}, and Wim Vyverman¹

¹ Laboratory of Protistology and Aquatic Ecology, Department of Biology, Ghent University, Krijgslaan 281-S8, B-9000 Gent, Belgium
E-mail: Sara.Moeys@UGent.be

² Department of Plant Systems Biology, VIB, Technologiepark 927, B-9052 Gent, Belgium

³ Department of Plant Biotechnology and Bioinformatics, Ghent University, Technologiepark 927, B-9052 Gent, Belgium

⁴ J. Craig Venter Institute, San Diego, CA 92121, USA

⁵ Department of Applied mathematics, Ghent University, Krijgslaan 281-S9, B-9000 Gent, Belgium

Diatoms are responsible for at least a quarter of oceanic carbon fixation, which is comparable to the primary production of the terrestrial rainforests. Despite their great ecological importance, not much is known about the diatom life cycle. This life cycle is characterized by a gradual cell size reduction linked to successive mitotic divisions, which ultimately leads to cell death. The latter can only be avoided by sexual reproduction, enabling cell size restitution via the formation of a specialized zygote, called the auxospore, that is able to expand. This essential link between cell size restitution and sexual reproduction is unique to diatoms.

Seminavis robusta is used as a model organism to study the life cycle of pennate diatoms. Like many pennates, this species is heterothallic, meaning that it has two mating types (MT⁺ and MT⁻) that need to form mating pairs for sexual reproduction to occur. We have shown that the decision of a mitotically active cell to differentiate into a sexually active cell is accompanied by the production of multiple info-chemicals. When cells pass a species-specific size threshold, they start secreting conditioning factors, indicated here as CF-P (secreted by MT⁺) and CF-M (secreted by MT⁻). In the presence of CF-P, MT⁻ cells produce a pheromone that attracts MT⁺ cells. This pheromone was recently identified as L-diprolone (Gillard et al. 2013). At the same time, sensing CF-M makes MT⁺ cells responsive to this attraction pheromone, presumably by inducing the appearance of receptors at the plasma membrane. Additionally, both CF-P and CF-M have the ability to arrest the cell cycle of the opposite mating type in G1 phase. By arresting the cell cycle, *S. robusta* is prolonging the period wherein cells are able to make the transition from mitosis to meiosis. In this way, they raise their chances of finding a mating partner within the right time frame.

To learn more about the processes that are targeted by CF-P, an RNA-seq experiment was conducted, where conditioned MT⁻ cultures (treated with CF-P) were compared to unconditioned cultures at several time points. Not only a repression of mitosis was observed, but also an upregulation of meiosis-related genes. This indicates that CF-P induces expression of meiosis genes, even though meiosis only starts after mating pairs are formed. These data also showed that diprolone biosynthesis probably starts with the production of proline from glutamate, because $\Delta 1$ -pyrroline-5-carboxylate synthetase (P5CS), which catalyses the first step in this conversion, is upregulated in conditioned cultures. This RNA-seq experiment can also provide insights in the signalling network regulating cell cycle arrest and diprolone production.

References

Gillard J., J. Frenkel, V. Devos, K. Sabbe, C. Paul, M. Rempt, D. Inze, G. Pohnert, M. Vuylsteke, and W. Vyverman. 2013. Metabolomics enables the structure elucidation of a diatom sex pheromone. *Angewandte Chemie-International Edition* 52(3):854-857.