symmetry of green algal coenobia resulting from adaptive phenotypic plasticity under planktonic life history

DISCUSSION

Analysis of coenobial shape in the green alga *Desmodesmus communis* during planktonic versus stationary life history revealed a pattern that highlights the role of morphology in the survival of these organisms. Coenobia subjected to sinking pressure produced an asymmetric phenotype, thus further causing a more intense sink in the water column. In contrast, coenobia living planktonically formed a symmetrical phenotype, resulting in better retention in the water column for longer periods of time.

When looking at an organism's ability to survive or reproduce, the focus is often more on genotypical properties, which is why our study focused on phenotype as an important factor. Our findings were based on a hypothesis that echoed previous studies looking at the shape of other Scenedesmal algae. However, the past studies mostly focused their attention on other environmental conditions that affected the shape, such as grazing pressure or the presence of certain substances in the environment (Chung et al., 2018; Lürling, 2003). Our study aimed to find a different reason for the formation of different phenotypes, and for this reason, we also faced some obstacles that were reflected in the experimental results.

In future studies of a similar type, additional degrees of mixing will need to be added, as three degrees were found to be insufficient. Large gaps were observed between the three stages, and it would therefore be interesting to know the transitional phases as well. The mixing device that was used for our study could also be considered insufficient as it did not simulate natural conditions with accuracy. Thus, a better selection of the mixing mechanism should be considered in the future.

This study initially focused on asymmetry in the area of the spines. However, since the spines of *Desmodesmus* are composed of cellulose, it could be argued that the result is not phenotypic plasticity but a momentary bending of the spine by the action of the water current on the slide (Dragoș et al., 2019). We, therefore, performed a secondary analysis in which we used capillaries to mechanically bend the spines. After several repetitions, we found that the spines did not bend under average pressure. Thus, it can be assumed that the observed asymmetry is indeed the result of phenotypic plasticity. However, to support our hypothesis, we performed the analysis again and excluded the spines. The analysis of coenobia without spines showed the same results as the analysis with spines and, thus, we can assume that it was correct.

Savriama & Neustupa (2010) have developed and tested a methodology for quantitative analysis of biradial symmetry in *Micrasterias rotata* and this has also proved to be very suitable for our hypothesis (Savriama & Neustupa, 2010). Through this approach we were able to reveal that *Desmodesmus communis* is most asymmetric in the transversal plane. In contrast, we know from previous diatom studies dealing with geometric morphometrics that diatoms are mainly asymmetric horizontally (Martindale & Henry, 1998). The reason why *Desmodesmus communis* has the highest asymmetry in the transversal region is still unknown and will need to be addressed in the future.

This study focused on the asymmetry of coenobia in *Desmodesmus communis* as a result of phenotypic plasticity (DeWitt et al., 1998). Using the innovative methods of Savriama & Neustupa (2010), it was possible to show that the symmetry of these algae has a great influence on their survival as it depends on their ability to maintain themselves in the water column (Morales & Trainor, 1997). *Desmodesmus communis* is a fully planktonic organism and therefore, asymmetry can be fatal for it. This study revealed that the highest level of asymmetry in this alga occurs in the transversal segment, which is relatively unusual compared to other algal groups. The study also showed that the spines on coenobia do indeed grow with some predisposition to be or not to be symmetrical, and the asymmetry is not caused by just a momentary bending due to pressure. However, future work needs to look into this in more depth and find correlations in these results.

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