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Should we sync? Seascape-level genetic and ecological factors determine seagrass flowering patterns

Marlene Jahnke[1#], Jordi F. Pagès[2†#], Teresa Alcoverro[2,3], Paul S. Lavery[2,4], Kathryn M. McMahon[4] and Gabriele Procaccini[1*]

[1]Department of Integrative Marine Ecology, Stazione Zoologica Anton Dohrn, Villa Comunale, 80121 Napoli, Italy; [2]Centre d'Estudis Avançats de Blanes (CEAB-CSIC), Accés a la cala Sant Francesc, 14, 17300 Blanes, Spain; [3]Nature Conservation Foundation, 3076/5, 4th Cross, Gokulam Park, 570 002 Mysore, India; and [4]Edith Cowan University, School of Natural Sciences, 270 Joondalup Drive, Joondalup WA 6027, Australia

Summary

1. Spatial and temporal heterogeneity in flowering occur in many plant species with abiotic pollination and may confer fitness advantages through mechanisms such as predator satiation or pollination efficiency. Environmental factors such as light quality or quantity and temperature play an important role in inducing synchronization on wide geographic scales. On a smaller geographic scale, external factors such as resource availability and herbivory are theorized to trigger flowering, while genetic factors may also play an important role.

2. In this study, we assessed the importance of ecological and genetic factors in shaping seascape-level spatial heterogeneity in flowering of the seagrass *Posidonia oceanica*. By investigating spatially close sites (<20 km) with similar seascape configurations and depth, we assume that major environmental drivers (temperature and light) were equivalent.

3. We assessed four ecological factors (productivity, leaf nitrogen and carbon content and herbivory) and three genetic factors (heterozygosity, relatedness and clonality) to assess three hypotheses for synchronized flowering in *P. oceanica*: (i) clone synchronization (internal clock hypothesis), (ii) variation in nutrient availability, potentially caused by spatial heterogeneity in herbivory rates or nutrient translocation *via* clonal integration (resource budget hypothesis) or (iii) kin selection and sibling synchronization.

4. Internal relatedness and heterozygosity had a significant positive effect on the abundance of flowers. Moreover, productivity and genotypic richness (clonality) were negatively associated with flower density, although at a lower level of significance. In addition, we found that clones were almost exclusively shared among mass-flowering patches and patches without mass-flowering, respectively.

5. *Synthesis*. The results shed new light on seagrass flowering patterns and on the mechanisms of flower synchronization at the patch level within a wider spatial scale. We found support for the kin selection hypothesis and indirect evidence for the resource budget hypothesis. Thus, a combination of mainly genetic but also ecological factors causes the observed heterogeneous flowering patterns in *Posidonia oceanica* seascapes. In addition, we found a strong positive relationship between the number of flowers and heterozygosity, adding evidence to the controversial association between heterozygosity and fitness when a limited number of loci are used. To our knowledge, this study is the first to link both ecological and genetic factors with flower abundance in a species with a presumed masting strategy.

Key-words: aquatic plant ecology, genetic diversity, herbivory, heterozygosity, internal clock, kin selection, *Posidonia oceanica*, primary production, relatedness, resource budget hypothesis

*Correspondence author. E-mail: gpro@szn.it
#These authors contributed equally.
† Present address: School of Ocean Sciences, Bangor University, Menai Bridge, Anglesey, LL59 5AB, UK.