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Abstract

In the Wadden Sea, mussel beds self-organise into spatial patterns consisting of bands parallel to the shore. A leading explanation for this phenomenon is that mussel aggregation reduces losses from dislodgement and predation, because of the adherence of mussels to one another. Previous mathematical modelling has shown that this can lead to spatial patterning when it is coupled to the advection from the open sea of algae – the main food source for mussels in the Wadden Sea. A complicating factor in this process is that the advection of algae will actually oscillate with the tidal flow. This has been excluded from previous modelling studies, and the present paper concerns the implications of this oscillation for pattern formation. The authors initially consider piecewise constant ("square-tooth") oscillations in advection, which enables analytical investigation of the conditions for pattern formation. They then build on this to study the more realistic case of sinusoidal oscillations. Their analysis shows that future research on the details of pattern formation in mussel beds will require an in-depth understanding of how the tides affect long-range inhibition among mussels.

Key words

mussel, pattern, Floquet, reaction-diffusion-advection, periodic travelling wave, Wadden Sea

Running Title

Tidal Flow and Patterns in Mussel Beds

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