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Dispersal of Microalgae
The Role of Biological and Physical Barriers

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Abstract

Microalgae are only a few micrometres to a millimetre in size, yet they constitute the base for aquatic food webs and are extremely important drivers in elemental cycling. Long it has been assumed that small organisms (<1 mm) that occur in high abundances, have global dispersal potential facilitated by winds, currents and vectors e.g. birds and insects. A growing body of evidence is however portraying a different story, that several microalgal species exhibit genetically differentiated populations at relatively regional geographic scales, and that populations can also differ in environmentally important traits.

In this thesis I present results from field studies and experiments designed test various physical and biological dispersal barriers to explain why despite the high dispersal potential in microalgae they exhibit reduced gene flow (exchange of genetic material). A marine species *Skeletonema marinoi* (Bacillariophyceae) and a freshwater species *Gonyostomum semen* (Raphidophyceae) were used to test the function of geographic distance and hydrographic connectivity (physical barriers) as well as local adaptation and priority effects (biological barriers) on gene flow between populations.

Geographic distance and oceanographic connectivity (currents) have demonstrated suitable predictors for mapping gene flow between populations of various marine microalgae species. Indeed we also found that over larger geographic regions in marine systems, population genetic patterns could be correlated with dispersal limitation caused by geographic distance and oceanographic connectivity. In addition, when genetic data was compared to environmental data population differentiation was moreover corroborated by differences in salinity and silicate concentrations, indicative of adaptation also driving population genetic divergence. Over smaller geographic distances, although reduced gene flow was even then evident, physical dispersal barriers became poor predictors of local population genetic patterns. Surprisingly, the role of connectivity by currents (marine systems) and rivers (freshwater systems) did not show any signs of facilitating dispersal that resulted in gene flow. In the freshwater study area, we found a weak effect of geographic distance, whereas in the small-scaled marine study, neither distance nor currents could explain signals of reduced gene flow, suggesting other influences driving population genetic differentiation, e.g. environmental selection against immigrants or persistent historical events reinforced by adaptation (monopolization).

Laboratory experiments using strains of *S. marinoi* confirmed that prior arrival to a vacant resource (founder event) was associated with a competitive advantage compared to later arriving strains (priority effects). In addition, strains were competitively superior in native salinity conditions, compared to non-native strains, supportive of local adaptation. Combined these results provide strong support for monopolization (priority effects reinforced by adaptation) as an additional important biological barrier to gene flow between nearby populations of microalgae.

In summary, this thesis provides important insight into the barriers that act in concert, but become evident at different spatial scales, to drive diversification of these ecologically central actors.