In the natural environment, there is considerable spatial heterogeneity in temperature. Since phenologies of many organisms are influenced by the temperature, thermal heterogeneity in the environment sometimes leads to seasonal asynchrony of organisms across habitat patches. Phenological asynchrony of organisms may prolong and strengthen certain species interactions which otherwise would be ephemeral and weak.

The mayfly *Ephemerella maculata* rears and emerges from sunlit mainstem rivers, flies into dark, unproductive tributaries, oviposits, and dies. While each adult *E. maculata* lives only for a few days, the migration of adult *E. maculata* to tributaries lasts for about a month due to their asynchronized emergence from the mainstem. Their mass migration subsidizes tributary predators that would otherwise be food-limited. A field manipulative experiment has shown that the one month long resource subsidy by *E. maculata* in summer significantly increases the growth of the juvenile steelhead rearing in the tributaries (Uno and Power, unpublished). We hypothesized that spatial heterogeneity of water temperature in the mainstem river causes the spatial variation in the emergence timing of *E. maculata*, leading to asynchronous *E. maculata* adult migration to tributaries, and that the prolonged resource subsidy increases the trophic efficiency, and consequently the total growth of juvenile steelhead trout over the summer.

In the sunny channel of the South Fork Eel River in Northern California, we have detected up to 5°C differences in daily maximum temperature within a 300 meter reach during summer low flow. In 2014, I investigated the effect of the spatial variation in the water temperature in the mainstem river on the emergence timing of *E. maculata* by incubating 600 individual *E. maculata* nymphs in flow-through buckets placed in various parts of the mainstem river channel with different temperature, and monitoring when *E. maculata* emerged from the buckets. *E. maculata* nymphs were naturally distributed at all reaches where we conducted the experiment, and the nymphs used for the experiment were captured at each location. *E. maculata* incubated in warmer reaches emerged 1-3 weeks earlier than the ones incubated in cooler reaches of the mainstem. At each location the emergence lasted approximately two weeks, while overall emergence from the mainstem was twice as prolonged, due to asynchronous temperature-mediated emergence. The adult *E. maculata* migration was observed in the tributaries for four weeks for the same period while *E. maculata* emerged from the buckets, indicating that the adult *E. maculata* migrating into tributaries come from various parts of the mainstem with various temperature regimes, earlier from warmer reaches and later from cooler reaches.

The effect of the subsidy duration on the growth of juvenile steelhead trout in tributaries will be examined by a large scale field experiment in summer 2015. We predict that the temporal extension of the subsidy period increases the efficiency of trophic transfer to juvenile steelhead trout and other recipient consumers in tributaries. The linkage of the spatial heterogeneity to the temporal duration of subsidies by the phenology of mobile organisms is infrequently quantified, but is likely of general importance. Dynamic consequences of multi-scale spatial heterogeneity in temperature and other environmental controls over ecological interactions in natural landscapes need more attention.

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