**Week 8: Balancing Selection**

|  |  |
| --- | --- |
| **12 Groups** | **49+ participants** |

**Summary:** Groups discussed balancing selection based on an empirical study investigating seasonal fluctuations on trait polymorphisms in Drosophila (Bergland et al. 2014, *PLOS Genetics*), and a modeling paper investigating segregation lift (Wittman et al. 2017, *PNAS*).

**1. What constitutes strong evidence for fluctuating selection, especially if the trait under selection is maintained by many loci with small effects?**

* The multiple lines of evidence provided by the Bergland paper (e.g., repeatable allele frequency variation by season, time vs. space comparison, links to fitness, natural experiment with frost event) were convincing argument
  + Could be strengthened by repeated measures (multiple seasons/populations), observing allele frequency shifts across different measurements of a particular environmental variable, linking genetic variation with phenotypic variation
* However, there are limits and difficulties in detecting changes given many loci of small effect
  + Requires consistent signal through space and time, which is difficult to detect/study.
  + The experimental protocols in Bergland et al. are convincing but require short-lived organisms that encounter predictable fluctuations extending longer than an individual’s life span.
    - Difficult to identity analogous systems in marine biome where environmental changes are often not as regular or predictable as seasonal changes on land.
* Fluctuating selection pressures prevalent in marine systems, but extent that fluctuating selection pressure produces/maintains genetic variation likely driven by both periodicity/frequency of selective regime relative to species’ generation time.
  + Species that exceed periodicity may evolve plasticity instead
  + Selection must also overlap with vulnerable or sensitive life stages and should be more prevalent in species with rapid life cycles.
  + Raises question of how widespread this mechanism is in maintaining genetic variation in nature.

**2. What are the benefits/consequences of fluctuating selection for long term changes in the environment?**

* Maintaining genetic variation for ecologically-relevant traits provides raw material for adaptive responses during directional shifts in the environment and improves odds of successfully adapting to rapid environmental change.
  + Potential disadvantage: Improving adaptive capacity may not be ideal given invasive species.
  + Genetic variation only applicable to stressors that have been encountered during evolutionary history. Unlikely to protect against new or extreme stressors.
* Fluctuating selection may maintain genetic diversity, but overall impact depends on several factors including strength of selection, difference in selection strength among different events within single fluctuation, relative length of fluctuation relative to generation time of species.
  + Selection must be strong enough to avoid allowing trait to drift to fixation, but weak enough to also avoid driving trait to fixation.
  + Directional environment shifts may diminish established adaptive variation for conditions that become increasingly rare, unless environment returns to original state. Therefore, periodicity in variability also matters – cannot be too long to lose genetic variation.

**Key Unknowns:**

* Detecting impact and divergence of many small effect loci: There is consensus that it is crucial, but little by way of solution. Can we come up with methods for detecting/studying polygenic traits?