Variation, selection and adaptation in fruit flies

Various studies have been done to analyze the genomics of adaptation in response to selective pressures, mostly using asexual organisms with relatively small genomes, such as bacteria. Now, a new study has looked at this process in a sexually reproducing organism—the tiny fruit fly (*Drosophila melanogaster*).

In asexual, single-celled bacteria, evolution generally occurs when a new, advantageous genetic mutation arises, 'sweeps' through a population and quickly becomes 'fixed' in the organism's genome. Some theorists believe that this same 'hard sweep' process also drives evolution in sexual organisms. But there are other mechanisms: 'soft sweeps', in which selection acts on existing genetic variation within a population, such that mildly favorable variants of multiple genes become more common; and 'incomplete sweeps', in which an advantageous mutation arises but does not become fixed. The new study suggests that these alternative mechanisms were responsible for evolution in fruit flies exposed to laboratory selection.

Alan John Lander Phillips

Anthony D. Long (University of California Irvine) led the study, in which populations of fruit flies were subjected to laboratory selection for accelerated development over 600 generations. Genomic analysis was used to compare these populations with ancestral control populations that experienced no direct selection on development. Long's group identified several dozen genomic regions in which the frequency of certain genetic variants was significantly different between the two populations (*Nature* **467**, 587–590; 2010). These results are not consistent with the type of genomic changes that would be expected to result from a hard sweep, as selection did not lead to the fixation of a new, advantageous genetic variant. Instead, the frequencies of many genetic variants had changed. "This research really upends the dominant paradigm about how species evolve," said Long in a press release.

The results indicate that in fruit flies, adaptation to selection for accelerated development involved changes in many genes, rather than just one. This observation has repercussions for the process of developing new treatments for certain diseases in humans. Disease susceptibility is a complex trait. For complex traits that are influenced by only a few genes, it should be relatively easy to develop treatments by targeting the products of these genes. For complex traits that involve many genes, however, developing effective treatments may be much more complicated. Michael Rose, an author of the *Nature* paper, stated in a story published in *The New York Times* (20 September 2010) that the study results are "very bad news for the pharmaceutical industry in general."

Monica Harrington

HEART ATTACKS AND SOCIAL ISOLATION

There is a strong link between certain psychological factors, such as depression and social isolation, and heart disease. Moreover, people who survive cardiac arrest and cardiopulmonary resuscitation are predisposed to develop a host of chronic physiological and psychiatric conditions due to neuronal damage caused by the temporary lack of blood flow to the brain. Now, a study with mice has shown that social interaction modulates some of the physiological and behavioral responses to a heart attack. Importantly, these results suggest that social isolation exacerbates certain responses to cardiac arrest (*Proc. Natl. Acad. Sci. USA* **107**, 16342–16347; 2010).

In this study, Greg Norman and colleagues at Ohio State University in Columbus housed male mice either alone or with a female mouse (whose ovaries had been removed). The research team implanted an electrocardiograph-like device into each male mouse. This device recorded and transmitted data, such as heart rate variability. After 2 weeks of the study, the researchers surgically induced heart attacks in some of the male mice and then resuscitated these mice. Other male mice underwent a sham control surgery. The researchers then analyzed tissue samples taken from mice 24 hours, 3 days or 7 days after surgery.

Within 24 hours after cardiac arrest, mice showed damage to the regulation of their heart rates, though the mice who lived with a female mouse showed significantly less damage than did the mice who lived alone. Specifically, the mice who lived with a partner had half as much neuronal cell death in the hippocampus region of the brain than did the mice who lived alone. The socially isolated mice appeared to show more depressive-like behavior as well. When placed in water, socially housed mice spent more time swimming and singly housed mice spent more time floating, which is considered a depressive symptom.

Within 3 days after cardiac arrest, the socially isolated mice had higher levels of the stress hormone corticosterone than did socially housed mice. While all mice recovering from heart attacks showed evidence of increased pro-inflammatory chemicals, the socially isolated mice appeared to have even higher levels of these chemicals than did the mice with partners. These results show that "[s]ocial isolation hits cardiac arrest victims from multiple angles," said Norman in a press release. "It is involved in results for cell death, inflammation and a variety of behavioral and physiological measures. You really see the ability of social interaction to influence recovery."

Kirsten Dorans