Lecture 24t. The ecological genetics of speciation (see F and H)

Adaptation to different host plant species by pea aphids.

1. Aphids from alfalfa prefer to settle on alfalfa, and aphids from clover prefer to settle on clover.
2. As the graph shows, the alfalfa aphids have higher fitness in alfalfa, and aphids from clover have a higher fitness on clover. **Hybrids have lower fitness on both**
3. Genetic data suggest a trade off: genes for high fitness on alfalfa confer low fitness on clover, and vice versa. And host preference genes seem to be linked to these fitness genes.
A coarse test for genetic specificity for infection of snails by trematodes

Dybdahl et al. (2008, Am Nat)
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Dybdahl et al. (2008, Am Nat)
Invasion into fresh water, divergence, and speciation in three-spine sticklebacks.

Hybrids between benthic and limnetic forms have low fitness compared to parental forms, which mate positively assortatively (e.g. benthic with benthic).
Lecture 25: MacroEvolution

Nothing in Biology makes sense except in the light of Evolution (Dobzhansky).

Nothing in evolution makes sense except in the light of ________________.

The following is from Coyne and Orr (1998).

Some have argued that Speciation is a by-product of conventional evolutionary forces, like selection and drift... Thus, the origin of species is simply an epiphenomenon of normal population genetic processes.

But, under the biological species concept (BSC), the origin of species requires joint consideration of two species, and usually an interaction between their genomes. The distinctive feature of the genetics of speciation is therefore epistasis

1. Necessarily true for post-zygotic isolation. True?
2. Usually true for pre-zygotic isolation. True?

Is speciation a by-product of conventional evolutionary forces?
Regarding the fossil record: can the patterns of rapid morphological change (evolution), followed by long periods of stasis be explained by conventional evolutionary forces?

Neo-Darwinian view

View from Gould & Eldridge
(plot morphology against time for both views. Remember Thomas Huxley?)

Quotes from SJ Gould
1. Is a new and more general theory of evolution emerging?
2. Marco-evolution is effectively decoupled from micro-evolution
3. NeoDarwinism is dead.
Macro-evolution (species or clade selection)

Remember the equation for density-independent population growth?

\[
\frac{dN}{dt} = \text{(births} - \text{deaths)} N = rN
\]

\[
\frac{dN}{dt} = (b - d) N = rN
\]

What if \( b \) = number of new species “born” And \( d \) = number of species “extinctions”

Could different clades have different values for \( r \)?

Factors affecting speciation (birth) rates

1______________________________ 4 ________________________________
2______________________________ 5 ________________________________
3______________________________ 6 ________________________________

Factors affecting extinction rate

1______________________________ 4 ________________________________
2______________________________ 5 ________________________________
3______________________________ 6 ________________________________
From Jablonski on larval ecology and macroevolution

**Consider** the following cases for marine invertebrates

1. Planktotrophic larvae (i.e., they eat plankton) many small larvae produced (r selected) widely dispersed (low isolation)

2. Non-planktotrophic larvae (they eat yolk) few, large offspring produced (K selected) dispersal is more local, leading to isolated pops.

**Expectations**

1. Clades with Planktotrophic larvae Large geographic range Low speciation and extinction rates

2. Clades with Non-planktotrophic larvae Smaller geographic range Higher speciation and extinction rates.
\(N\) = Non-planktotrophs  \(P\) = Planktotrophs  Note that non-planktotrophs have higher rates of speciation, independent of trophic group.  *per species per million years.

Note the data are consistent with expectations (listed above)
“The causal mechanisms for the observed patterns... probably lie at the hierarchical levels above the traditional Neodarwinian one of the individual organism. I am most emphatically not invoking traditional group selection, but species selection in the strict sense. Differences in genetic population structure and geographic range – species level traits that are not reducible to the organismic level – are responsible for the observed patterns.” From: Extinction of geographic ranges of late cretaceous gastropods (Jablonski, D. Bull. Mar. Sci. 39: 565-587)

What does this all mean?

Are lineages selected to speciate? _______

What is macroevolution? _____________

Is it decoupled from microevolution? ___________

What is the “currency” of microevolution? _______

What is the “currency” of macroevolution? _______
Speaking of extinction... How do we explain the strikingly constant rate of extinction in the above graphs? (Data from van Valen 1973) Write answer here:
How do we explain these results? Why can frogs and birds hybridize for much longer periods after divergence from the common ancestor?

**Figure 1.** Hybridizability and divergence time in vertebrate lineages (compiled from Refs. 8–10). The estimated divergence times between pairs of species capable of producing viable hybrid offspring in frogs (N = 50 pairs), birds (N = 36 pairs) and mammals (N = 31 pairs) are based on an albumin clock calibrated at 1.7 immunological distance units per million years in mammals and frogs, and 0.6 immunological distance units per million years in birds. It should be noted that divergence times were determined only for species known to produce viable hybrids (either in nature or from animal husbandry studies) and thus do not represent a random sample of the taxa. While the precise form of each histogram depends, of course, on the particular species sampled, the magnitude of the disparity between mammals and the oviparous tetrapods makes it extremely unlikely that differences are due to sampling artifacts.