Population genetics of speciation

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Why discrete species?

Natural selection

• Variation
• Heredity
• Selection
(Usual summary of Darwin.)

Questions

• Why diversity?
• Why discrete variants?
• (Why sex?) [genes vs. individuals]
• Why reproductive isolation?
Speciation concepts, classical

• Darwin:
  It is advantageous to be different from the competitor.
  Fortunately, he was oblivious about diploid genetics. 😊

• Allopatric speciation (Mayr, mainstream in many circles)
  Species is defined by reproductive isolation. It can emerge in allopatry, as a genetic accident.
  Speciation has nothing to do with adaptation – not intrinsically, at least.
  Does not seem to be very parsimonious...
  Empirical support is weak...
Speciation concepts, new wave

- Adaptive speciation (theory)
  Driven by frequency-dependent selection.
  Corresponds to Darwin’s intuition.
  Not always taken seriously by population geneticist.

- Ecological speciation (empirical)
  Speciation is observed, as adaptation to a new ecological possibility; often with significant gene flow.

These two are actually the same thing.
Evolutionary branching of clonals

MacArthur-Levins type competitive Lotka-Volterra model with a 1D niche axis, „beak size”.

Fitness is affected by the population.

Evolution converge to a fitness minimum, induced by the population itself – and branches there.

Speciation?
Ecology behind: Continuous coexistence?

Gyllenberg & Meszéna (2005): Continuous coexistence is structurally unstable
Adaptive speciation (with Ulf Dieckmann)

Three phases
1. Initial adaptation
2. Slow loss of variance
3. Completion of isolation via sexual selection

Why the 2\textsuperscript{nd} phase is so slow?
Map of interactions

Large locus number

Trait distribution and specific alleles become independent.
Population genetics of stabilizing selection

Analytic theory

\[
\frac{d \text{ allelic variance}}{dt} \sim \frac{\text{population averaged (fitness)}''}{\text{locus number}}
\]
Details
Summary: Why discrete species?

- Different regulations → different ecological possibilities (niches)
- Structure of regulating feedback allows discrete coexistence only.
- Sexual reproduction is able to maintain wide genetic variance. However: generically it will be under selection.
- Fitness minima (disruptive selection) → assortativity
- Fitness maxima (stabilizing selection) → decreasing allelic variance
- Assortativity + low segregation variance → reproductive isolation
- Sexual selection (unavoidable) → completion of isolation.
Diversity and speciation are adaptations to a world with multiple niches.

(And, you cannot reach to this conclusion without considering population regulation with a conceptual edge.)
Thanks

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