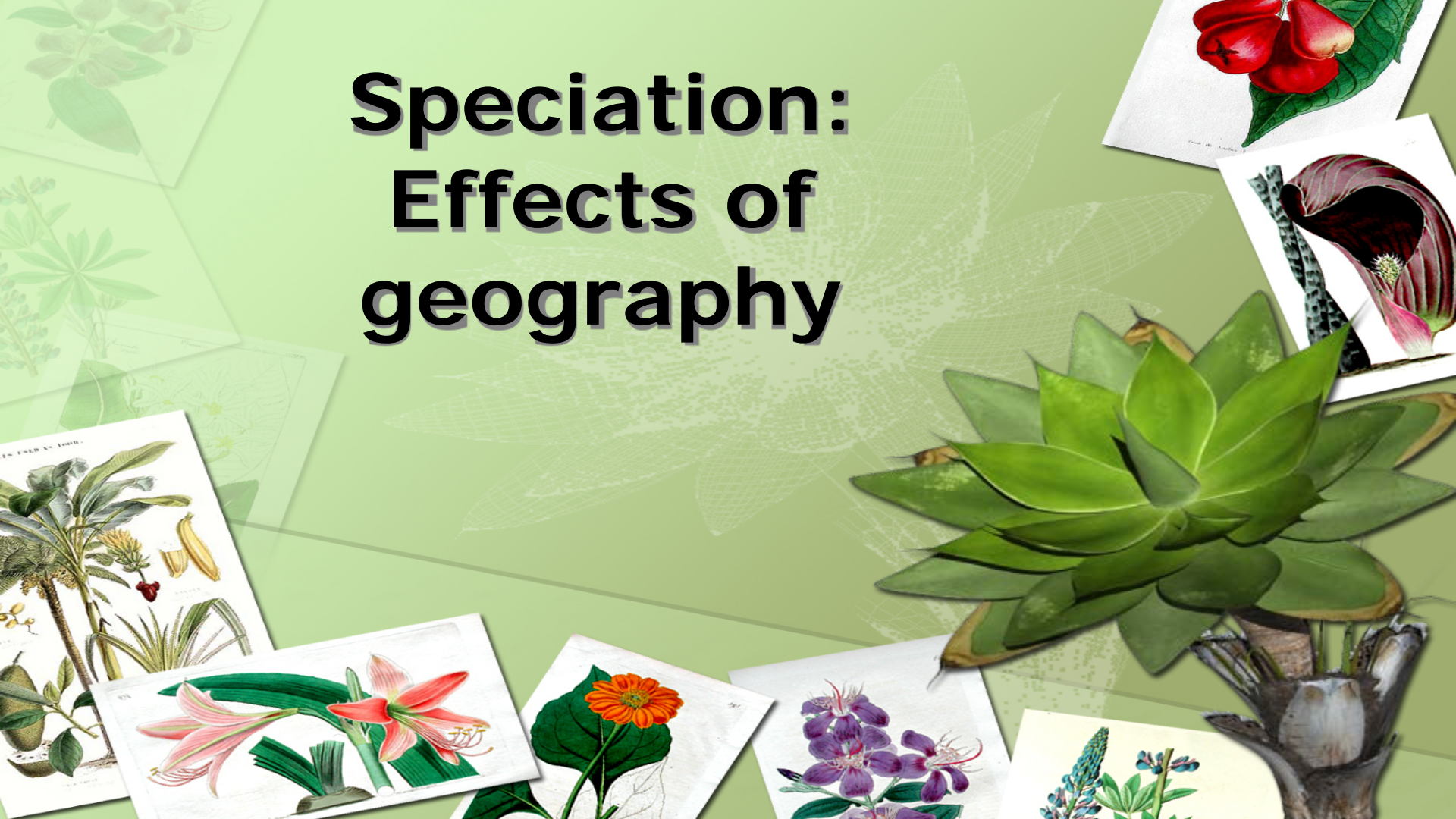


# Speciation: Effects of geography



# Some big questions on origin of species

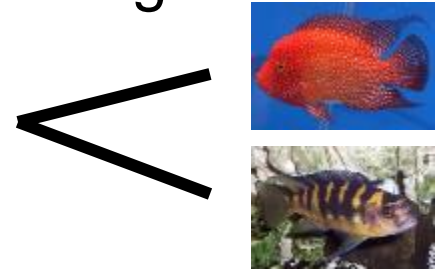


- Why do these clusters not “fuse” - why don’t we see all the intermediates?
- **How does geography affect species formation?**
  - What is the genetic basis of species formation?



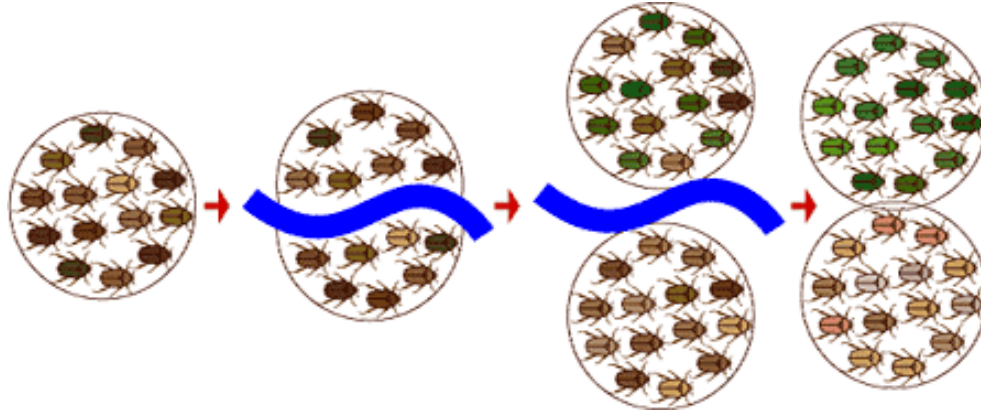
# What makes new species evolve?

- Formation of barrier traits
- Cordoning off of some or all of genome from gene exchange
- Random/ stochastic processes
- Natural selection acting *directly* on traits to prevent gene exchange
- Natural selection incidentally forming traits



# Models of species formation

## 1. Geographic isolation



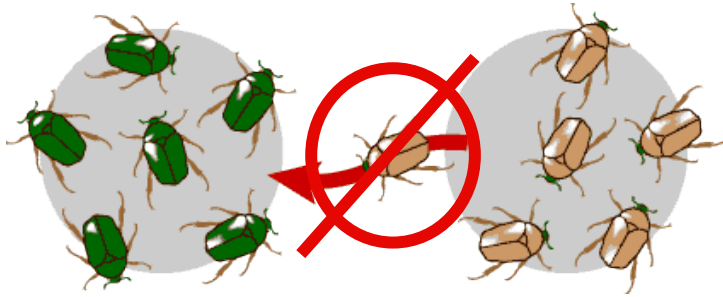
- A) One population
- B) Become separated by mountain range or stream
- C) Changes happen within populations on opposite sides
- D) Come back into contact but now different

# What made these “changes” happen?

- New, random mutations arose in one population but not the other
- Abundance of gene forms changed on the two sides randomly (genetic drift)
- Environment different on the two sides, so different gene forms were favored by natural selection
- **NOT** selection for barrier effect specifically

# Concept

- Gene flow is a “homogenizing force” in evolution

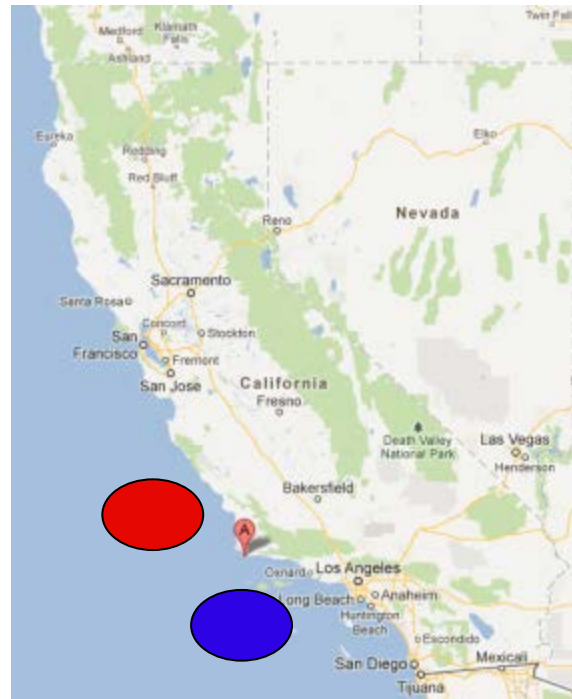


- If a long period of time elapses with no gene exchange, it is easier to diverge into two differentiated populations



# Evidence

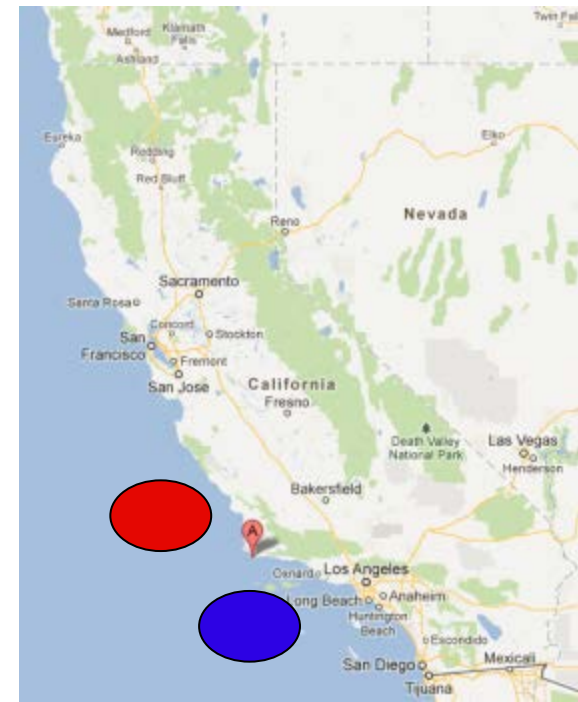
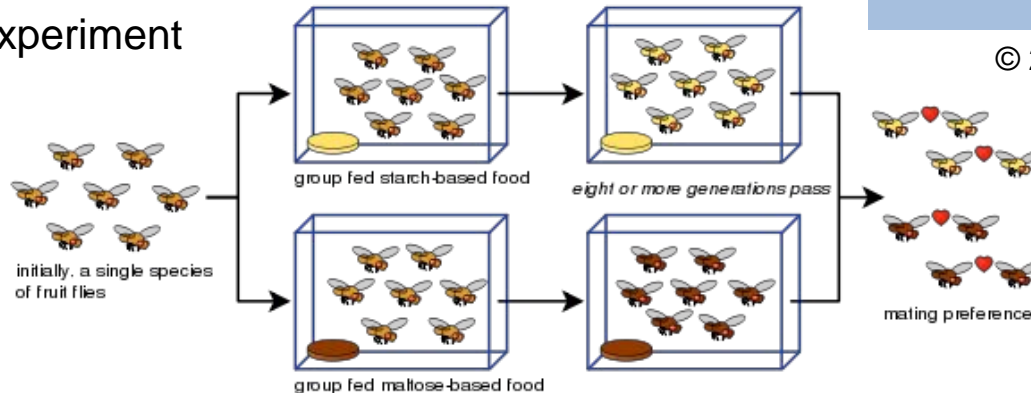
- **Species boundaries associate with geographic barriers (past or present)**
  - *Point Conception, CA*: 21 species of snails, algae, and barnacles have ranges ending there, and close relatives on other side



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# Evidence

- **Species boundaries associate with geographic barriers (past or present)**
  - *Point Conception, CA*: 21 species of snails, algae, and barnacles have ranges ending there, and close relatives on other side
- **Experimental studies'**
  - Selection experiment

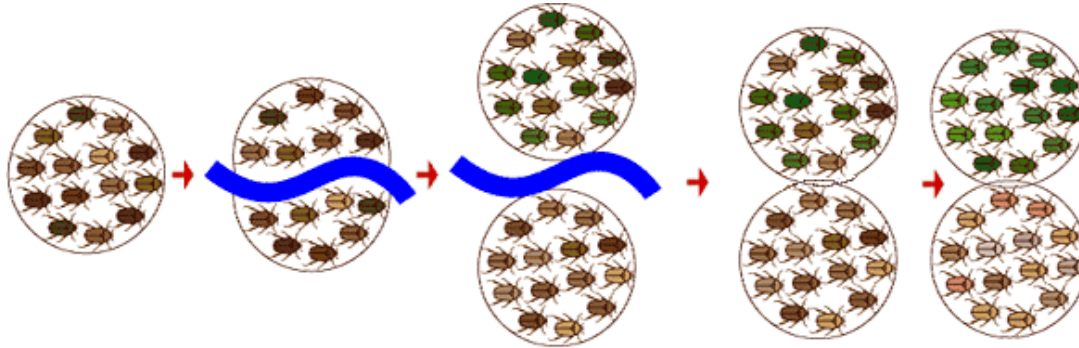


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# Models of species formation

## 2. Geographic isolation, but regain contact before speciation



- A) One population
- B) Become separated by mountain range or stream
- C) Changes happen within populations on opposite sides
- D) Come back into contact but now a little different
- E) Continued divergence and formation of barrier traits

# Hybridization is “bad”

- Anything that facilitates organisms passing on their genes favored by selection
- Species hybrids often sterile
- Producing sterile species hybrids costly
  - Genes not passed on in sterile hybrids
  - Waste gametes and parental efforts



# Hybridization is “bad”

- Alleles that “prevent” (or “reduce”) mating with the other species will be ***favored*** by natural selection
  - Reduce bad hybridization



# Hybridization is “bad”

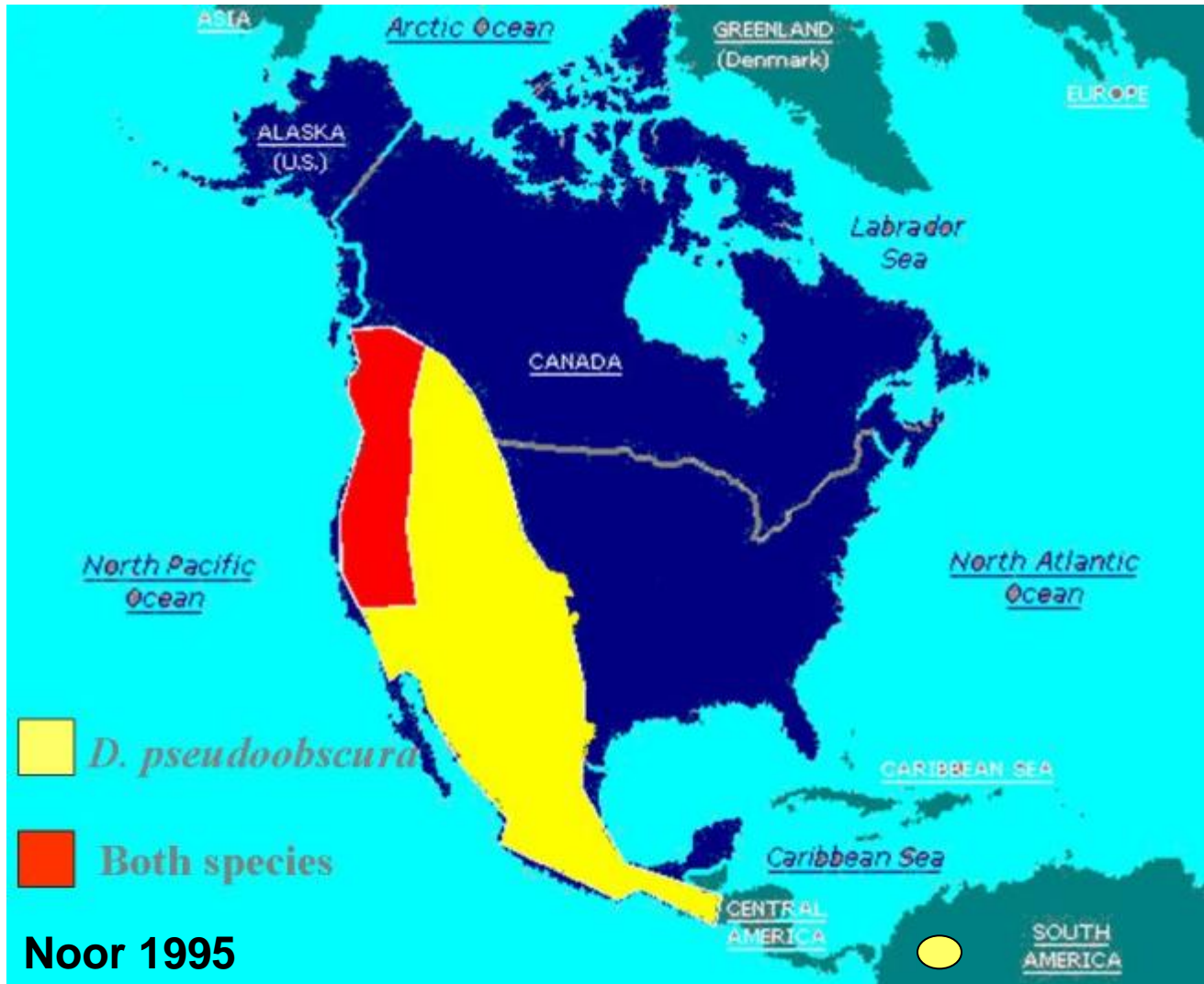
- Alleles that “prevent” (or “reduce”) mating with the other species will be ***favored*** by natural selection
  - Reduce bad hybridization
- This selection only operates in populations where you CAN mate with the other species



Noor' s PhD study (1995):  
***Drosophila pseudoobscura***  
***D. persimilis***

- Species that look exactly alike
- Hybrid males sterile (so bad at passing on genes), hybrid females fertile
- Mate in nature, though not very much
- Native to North America and co-occur in some areas







High discrimination

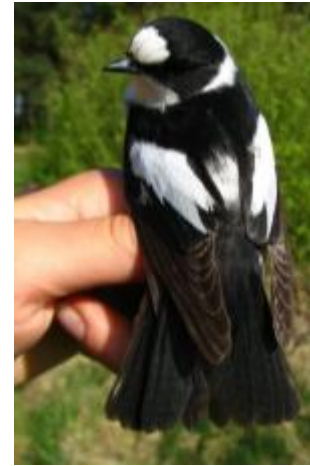
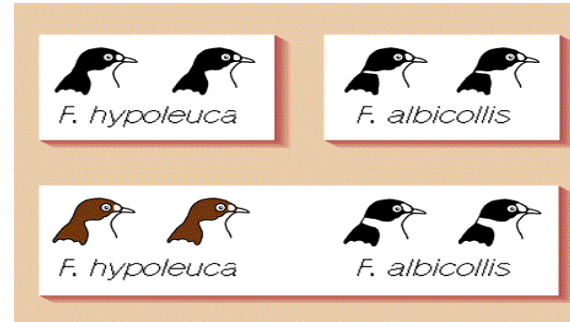
Low discrimination



Noor 1995

# And More Evidence...

- Differences in sexually-preferred characters in areas where species overlap (variation within species).
  - Pied & collared flycatcher
- Co-occurring species show higher mating discrimination than geographically separated ones (variation among species).





# Traits that prevent bad hybridization favored

- Habitat differences between species can prevent making bad hybrids
- Timing differences between species can prevent making bad hybrids
- Mate preference differences between species can prevent making bad hybrids

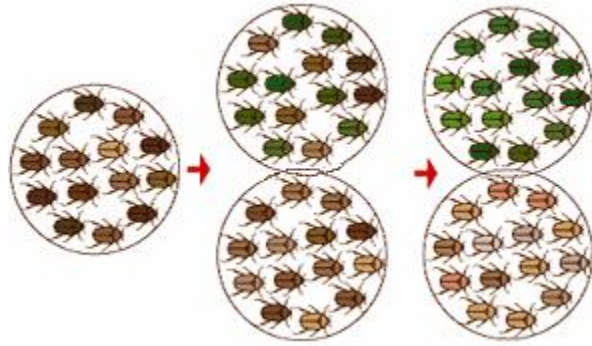


# Traits that prevent bad hybridization favored

- Habitat differences between species can prevent making bad hybrids
- Timing differences between species can prevent making bad hybrids
- Mate preference differences between species can prevent making bad hybrids
- Hybrid sterility- too late- already made bad hybrid (and wasted gametes/ parental care)

# Models of species formation

## 3. No geographic isolation



- A) One population
- B) See partitioning into distinct types, interbreeding reduced
- C) Continued divergence and formation of barrier traits

# Why split?

- Distinct niches, filled by types in which intermediates (or switchers) are less fit.
  - Trade-offs in adaptation.
- Requires strong natural selection.

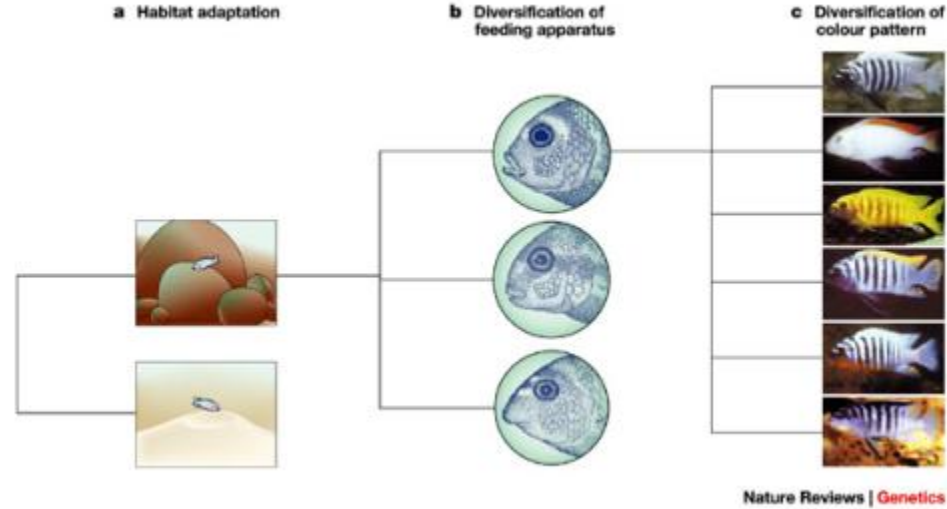






# Evidence

- Crater lake cichlids
  - Lakes isolated historically
  - Diverse niches within
  - Nearest relatives all in same lake



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# Diversity of answers...

- Can have natural selection incidentally cause new species
- Can have natural selection directly drive formation of new species
- Random processes can contribute
- How often does each occur???



# Quick recap:

- From geographic patterns, can infer evolutionary processes causing species splits
- Evidence for diverse modes of species formation, and diverse roles of natural selection or random processes
- Frequency uncertain- that's the big question now.



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