Do Species Change?

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Outline

- Do species change?
- Do they change into new species?
- Does evolution make big changes?

"Within the period of human history we do not know of a single instance of the transformation of one species into another one, if we apply the most rigid and extreme tests used to distinguish wild species from each other. It may be claimed that the theory of descent is lacking, therefore, in the most essential feature that it needs to place the theory on a scientific basis."

Thomas Hunt Morgan in *Evolution and Adaptation* (1903)

"I have never seen a dog specially created and I have never seen one type of animal evolve into another type, and I shall therefore continue to record a verdict of 'not proven' until either the special creationist or the evolutionist produce persuasive proof in favour of their views."

Arnold Lunn in *Is Evolution Proved?* (1947)

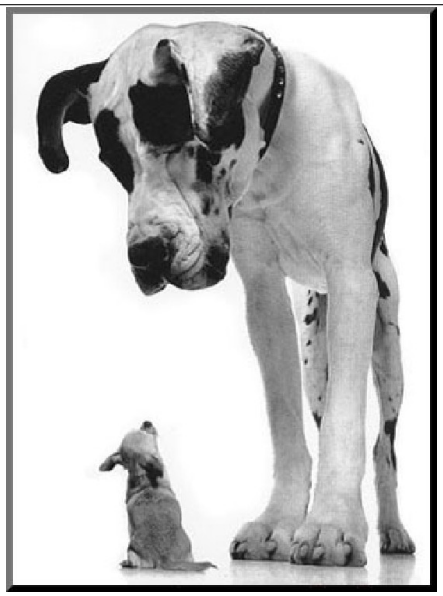
"Fossils reveal that life forms on Earth have never undergone even the slightest change and have never developed into one another."

Harun Yaha in *Atlas of Creation* (2006)

There is no doubt that species change

In the short run, you can watch evolution happen.

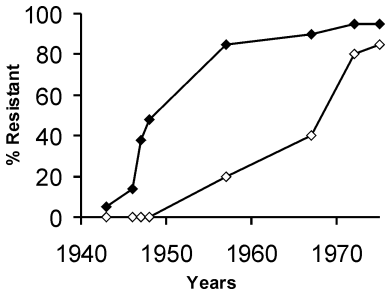
- Artificial selection
- Resistance to antibiotics, pesticides, and herbicides
- Darwin's finches



The history of domestic animals makes it clear that species change.

But are they a special case?

Resistance to penicillin



Symbols: ◇, community; ♦, hospital.

1943 penicillin introduced
1944 1st resistant strains
1950 40% resistant in hospitals
now 98% are resistant

Resistance to methicillin

1961 methicillin introduced
1998 50% resistant in hospitals
2005 kills 3000/yr in UK alone

The last resort: vancomycin

- Introduced in 1958
- Cannot be taken orally (I.V. only)
- Early forms toxic to ears and kidneys
- Used when all other drugs fail
- Vancomycin-resistant staph appeared in 1997 in Japan
- Has spread to England, France, US, Asia, and Brazil

Other resistance problems

Pesticide resistance

- $>$ 500 species of insect and mite
- $\sim$ 6 species of rat

Herbicide resistance

- $>$ 270 species of weed

Why invest in antibiotics?

- Once introduced, an antibiotic is useful for only a few years.
- After that, bacteria are resistant, so no one will buy the antibiotic.
- There is not much in it for the drug company.
- Research spending on antibiotic research has declined.
- The same is true of pesticides and herbicides.

Where we are so far

- Evolution can happen only if species change.
  - This evidence on this point is clear: they do change.
- Evolution also requires that species split to form new species
  - Do they?

Can evolution make new species?

- How would we know?
- What *is* a species, anyway?

Species are distinct

- Most species are distinct; don't grade into one another.
- Lions and leopards but no liopards.
- Why?

Reproductive isolation results from

1. Mate preferences
2. Infertility of hybrid matings
3. Reduced fitness of hybrids
4. Any of these can keep species separate.
5. If reproductive isolation arises naturally, then so do new species.
6. Does it?

"If it could be demonstrated that it is impossible to breed selectively, from any stock, a form which shall not breed with another, produced from the same stock;. . . I hold that Mr. Darwin's hypothesis would be utterly shattered."

Thomas Henry Huxley (1863)

Three kinds of evidence on speciation

- polyploid hybrids
- selection experiments
- ring species

Kew Primrose

- 1899: sterile hybrid between primrose species.
- 1905: one plant became fertile.
- But couldn't breed with either parent.
- Had 2× the chromosomes of either parent.

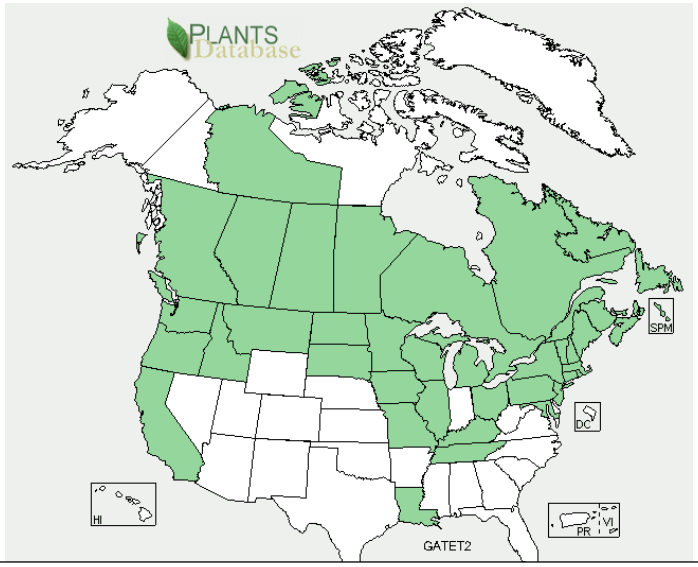
Why polyploid hybrids are new species

- Hybrids are often sterile
- One reason: chromosomes cannot pair
- Polyploids: pairing is restored if chromosome count doubles
- Polyploids can mate w/ each other but not with parental species
- New species are created this way all the time.

Müntzing 1932

- Reconstituted a wild species (*G. tetrahit*, a hemp-nettle) by hybridizing two other wild species.
- The new *tetrahit* was polyploid.
- Reproductively isolated from parents but not from wild *tetrahit*.

G. tetrahit in USA



What polyploid hybrids teach us

- There is nothing magical about species.
- Many of the plants you see in the grocery story and the florist shop are new polyploid species.
- Happens all the time in nature.

But. . .

"You seem to think that because some freak plants have been bred, which, on account of the duplication of their chromosomes, are infertile when crossed with the parent, you have produced some experimental evidence in favour of evolution. That being so, doubtless, in your next letter you will tell us all about it and above all show us how it helps the theory in the case of animals which differ from plants in that polyploidy is practically unknown in the higher animals and very uncommon in the lower ones."

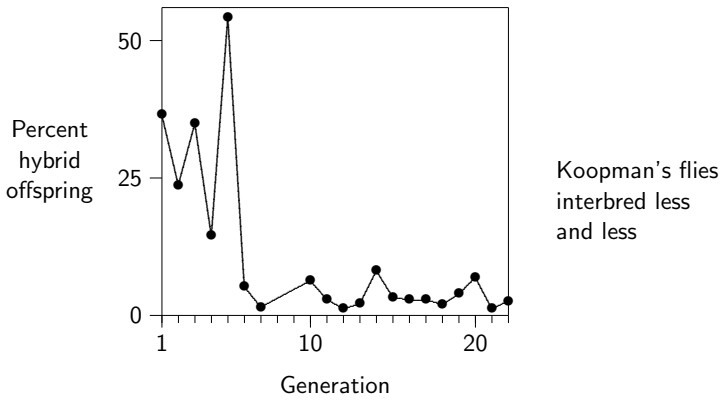
Douglas Dewar (1947)

Dewar's objection

- Most polyploid species are plants.
- Yet closely related animal species often have the same number of chromosomes.
- They did not arise as polyploid hybrids.
- How do we know that new *animal* species arise?
- And can we make it happen in the laboratory?

Karl Koopman 1950

- began with 2 closely-related species of fruit fly, which often interbred at cool temperatures
- Koopman discarded hybrid flies
- interbreeding gradually declined



Since Koopman

- Many experiments have selected against interbreeding.
- Rate of interbreeding usually declines.
- But *seldom reaches zero*.
- Why is it so hard to split a species completely in two?

Speciation is often slow

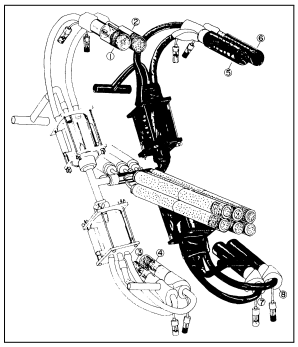
- Some isolation between pops within species
- Some interbreeding between species separated for millions of years
- Yet experiments run only a few generations

Speciation by habitat selection

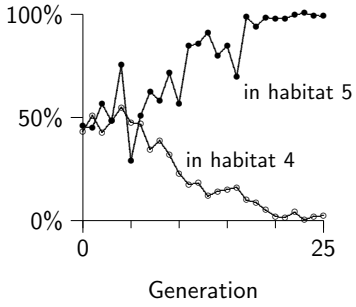
Rice and Salt (1984) found an answer:

- In nature, animals choose their own habitats.
- Habitats have many dimensions: warm/cold, light/dark, high/low, shrubs/grass, etc.
- The fruit flies who reach the bananna on your table have all made the same decision at many steps.
- Rice and Salt built an apparatus that mimicked this complexity.

Apparatus of Rice and Salt



- Twisted, 3D maze of tubing.
- Adult flies emerge in middle of maze and make their way to one of 8 habitats.
- The only flies who got to breed were those who reached the same habitat as their parents.



Results of Rice and Salt

- Percentage of flies choosing habitats 4 (○) and 5 (●) that were hatched in habitat 5.
- By end, all flies chose the habitat where they were conceived.
- Complete reproductive isolation.
- Rice and Salt had split a species in two.

We have seen that

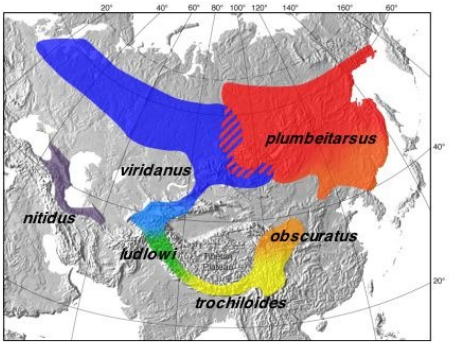
Plants speciate both in the lab and in nature.

Animals speciate in the lab.

Do animals also speciate in nature?

Greenish Warbler

Distribution of Greenish Warbler

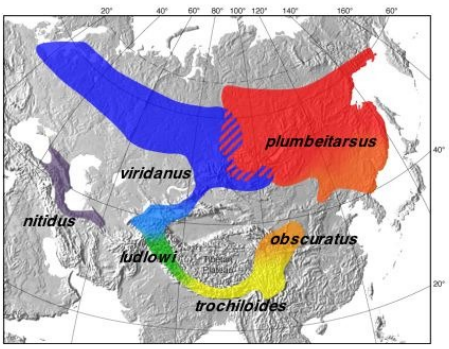


- adjacent pops interbreed
- genetic distance incr around ring
- no interbreeding in overlap

Tibetan Plateau

Average elevation 4500 m (14,800 ft). This is the habitat that the Greenish Warbler avoids.

Speciation



- Currently 1 species
- If middle pops went extinct: 2 species
- Evolution can make new species.

Evidence of change within species

- pathogens resistant to antibiotics
- insects resistant to pesticides
- plants resistant to herbicides
- Darwin's finches

Evidence that species split to form new species

- Polyploidy
- Selection experiments
- Ring species