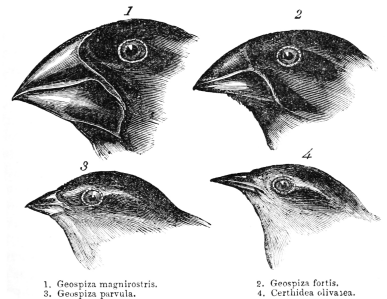


Natural Selection: Darwin's Four Postulates

Natural Selection: Darwin's Four Postulates

1. Individuals within populations are variable
2. Some of these variations are heritable and are passed on to offspring
3. In every generation, some offspring are more successful at surviving and reproducing than others
4. Survival and reproduction is not random, but are instead a function of variation among individuals

Evolution of beak shape in Darwin's Finches



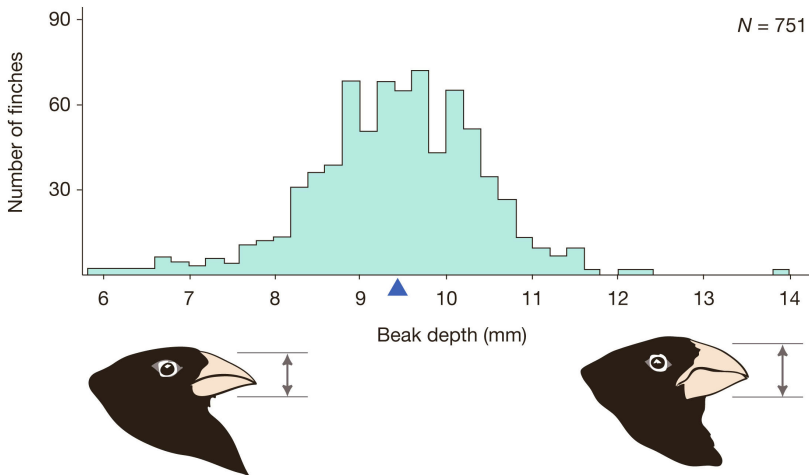
Galápagos finches



¹Image: Public Domain, John Gould

²Image: Public Domain

Postulate 1: Individual variation in beak depth

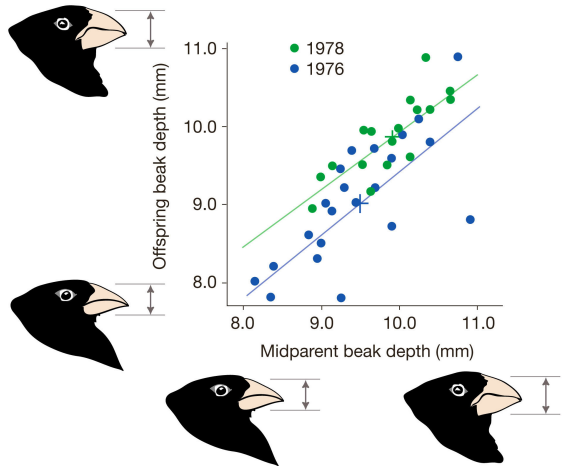


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¹Image: Freeman, S., & Herron, J. C. (2007). Evolutionary analysis (Vol. 834). Upper Saddle River, NJ: Pearson Prentice Hall. Page 82.

Postulate 2: Beak depth is heritable

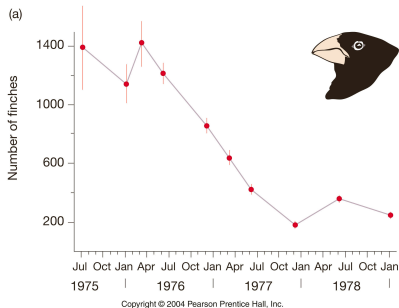
Parents with deeper beaks tend to have offspring with deeper beaks, and vice versa.



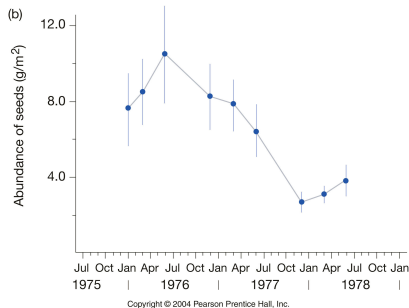
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¹Image: Freeman, S., & Herron, J. C. (2007). Evolutionary analysis (Vol. 834). Upper Saddle River, NJ: Pearson Prentice Hall. Page 83.

Postulate 3: More offspring produced than can survive



Finch number declines on the island of Daphne Major during a 1977 drought.



Abundance of seeds on the island of Daphne major decreases during 1977 drought.

Note: Error bars indicate standard errors around the means.

¹Images: Freeman, S., & Herron, J. C. (2007). Evolutionary analysis (Vol. 834). Upper Saddle River, NJ: Pearson Prentice Hall. Page 86.

Are more offspring produced than can reproduce?

Organism	Reproductive potential
Aphid	524 billion in 1 year
Elephant	19 million in 750 years
Housefly	191×10^{18} million in 5 months
Mushroom fly	1800 square metres in 35 days
Bacteria	Cells cover earth 2+ meters in 24h
Starfish	10^{79} in 16 years

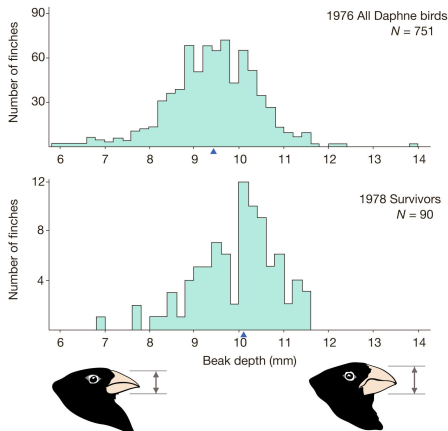
Note: 10^{79} is the estimated number of electrons in the universe

Postulate 4: Nonrandom survival and reproduction

Survival and reproduction is not random with respect to beak depth

Finches with larger beaks more likely to survive the drought

Change in number and traits of seeds caused evolution of beak size



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¹Images: Freeman, S., & Herron, J. C. (2007). Evolutionary analysis (Vol. 834). Upper Saddle River, NJ: Pearson Prentice Hall. Page 87.

Points for understanding natural selection

1. Natural selection acts on individuals, but its consequences occur in populations.
2. Natural selection acts on phenotypes, but evolution consists of changes in gene frequency.
3. Natural selection is not forward looking.
4. Natural selection can produce new traits, even though it acts on existing traits.

Points for understanding natural selection

5. Natural selection does not lead to perfection
6. Natural selection is non-random, but not progressive

Points for understanding natural selection

1. Natural selection acts on individuals, but its consequences occur in populations

- ▶ When a population of Galápagos finches evolved larger beaks for eating seeds, the beak sizes of individual finches did not change
- ▶ Instead, finches lived or died as a result of their beak sizes, and the population as a whole evolved larger average beaks

Points for understanding natural selection

2. Natural selection acts on phenotypes, but evolution consists of changes in gene frequency.

- ▶ In Galápagos finches, if beak size was entirely environmentally determined, and not heritable, selection might have happened, but not evolution
- ▶ Evolution requires selected traits to be passed on to the next generation

Points for understanding natural selection

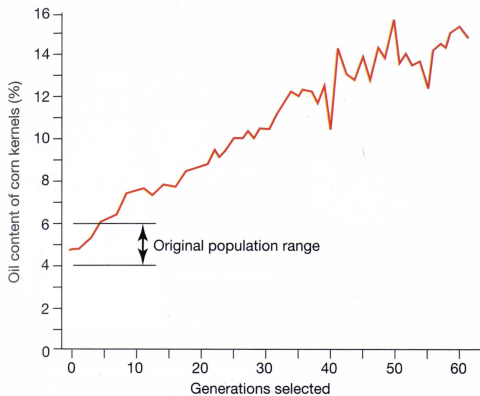
3. Natural selection is not forward looking.

- ▶ Individuals in each generation are descended from the individuals that survived and reproduced in the previous generation
- ▶ If local environmental conditions change, natural selection may act differently. **Natural selection cannot anticipate future environmental changes.**

Points for understanding natural selection

4. Natural selection can lead to new traits, even though it acts on existing traits.

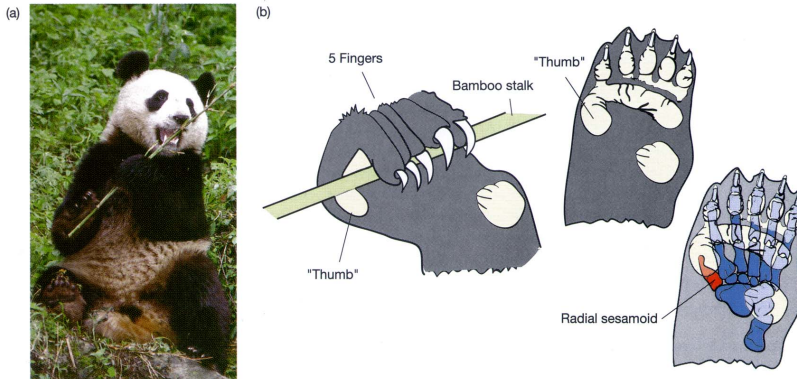
Example: selection on oil content in corn



¹Images: Freeman, S., & Herron, J. C. (2007). Evolutionary analysis (Vol. 834). Upper Saddle River, NJ: Pearson Prentice Hall. Page 91.

Points for understanding natural selection

4. Natural selection can lead to new traits, even though it acts on existing traits.

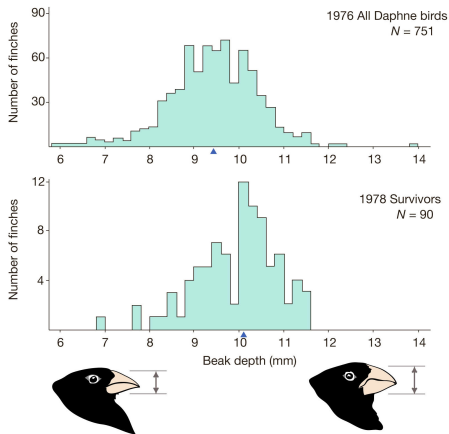


¹Images: Freeman, S., & Herron, J. C. (2007). Evolutionary analysis (Vol. 834). Upper Saddle River, NJ: Pearson Prentice Hall. Page 92.

Points for understanding natural selection

5. Natural selection does not lead to perfection.

Example: Change in beak depth in Galápagos finches after a drought



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6. Natural selection is non-random, but not progressive.

- ▶ Mutation and recombination produce heritable variation that is random with respect to phenotypic changes
- ▶ Selection, by definition, is the non-random selection of favourable variants produced by the above