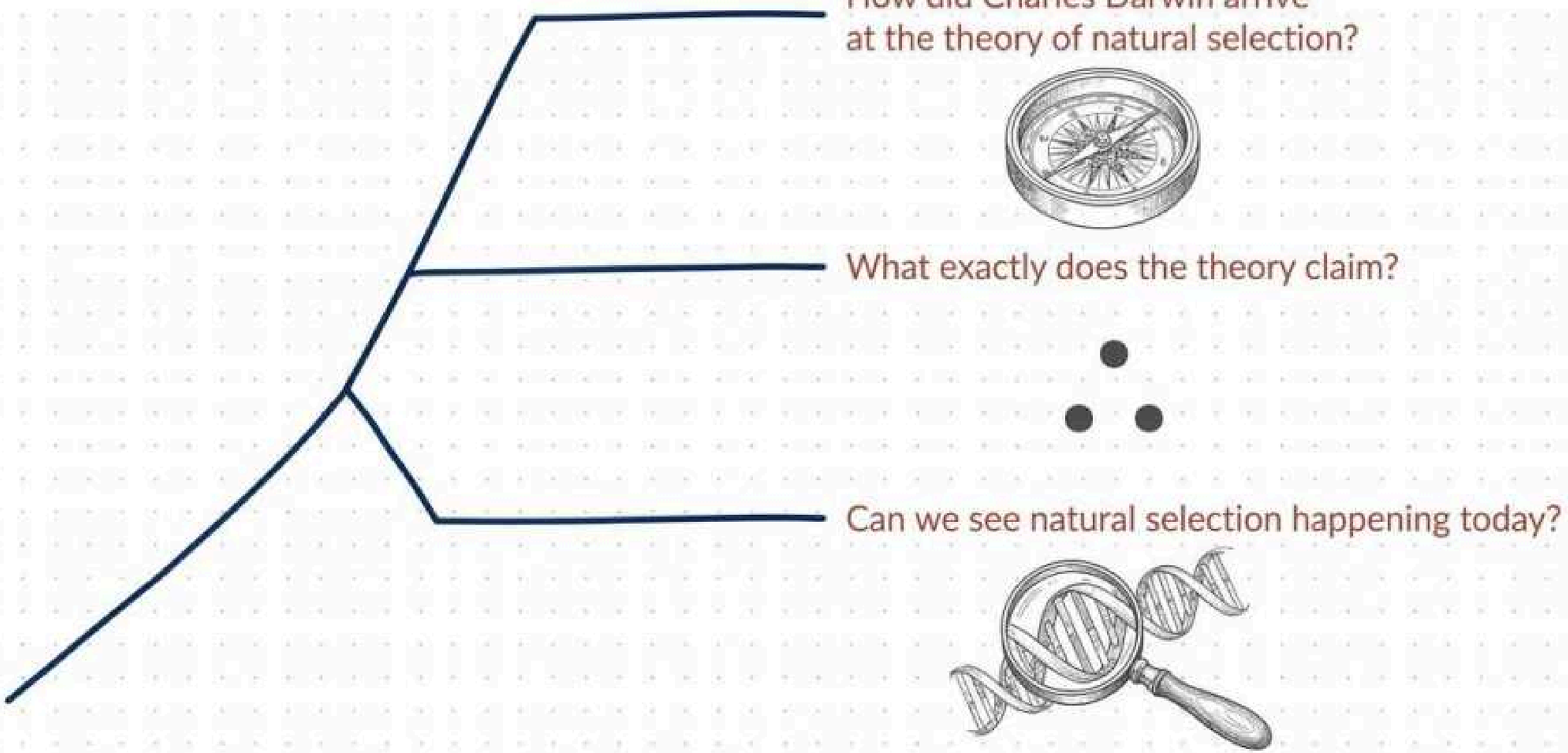
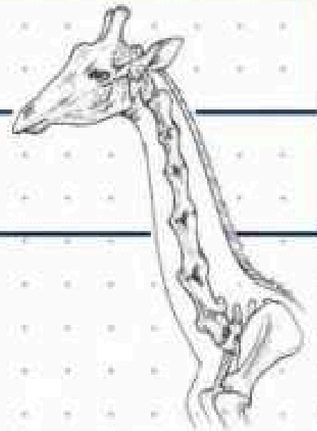
Three foundational questions drive our understanding of natural selection.



Early theories lacked a convincing mechanism for biological change.

Jean-Baptiste Lamarck (1809)	Charles Lyell
Domain: Biology	Domain: Geology
Proposed Mechanism: Use and disuse	Proposed Mechanism: Gradualism
Trait Type: Acquired	Timescale: Extremely old Earth
Example: Giraffe neck stretching	

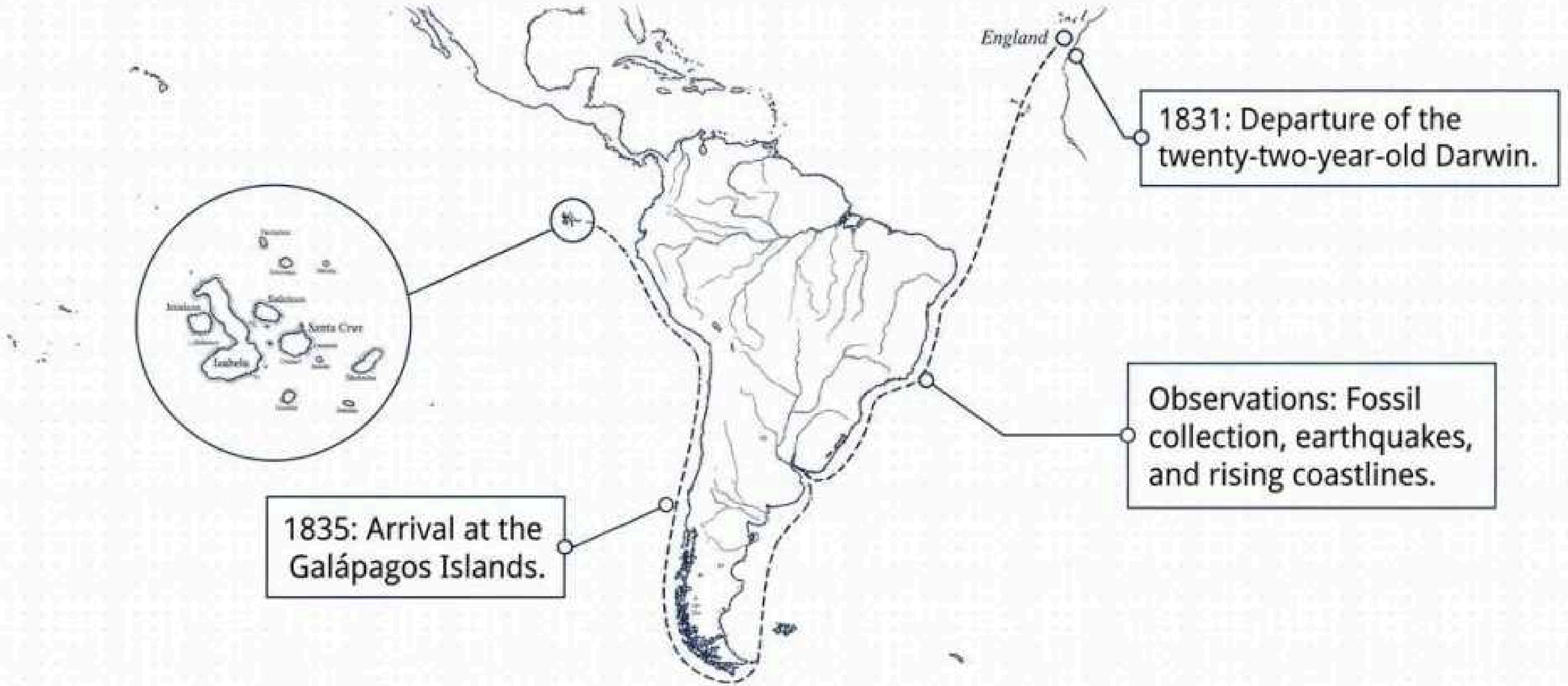


Missing Variable

The biological mechanism for how species change over deep time.

The voyage of HMS Beagle provided the raw geological and biological data.

¶ 1.3

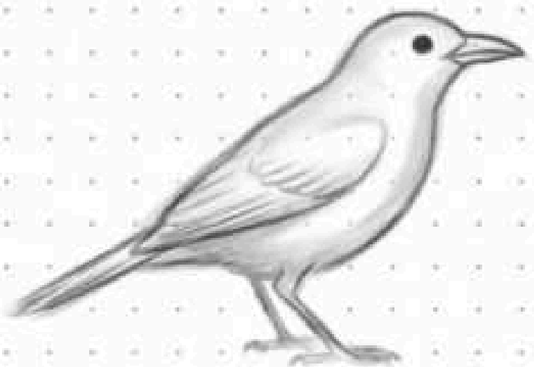


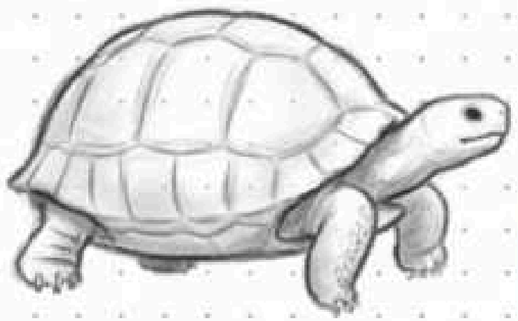
1831 1832 1833 1834 1835 1836

Continuous progression of geographic variance observed from place to place.

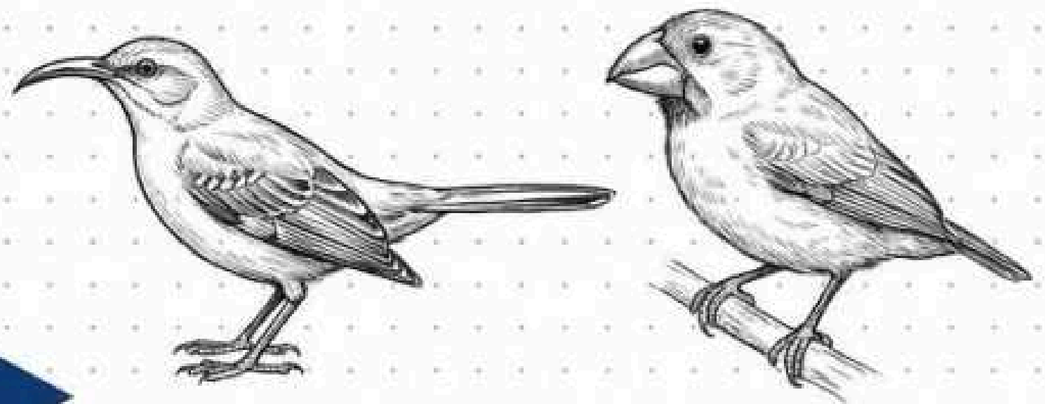
Isolated geography drives distinct morphological divergence.

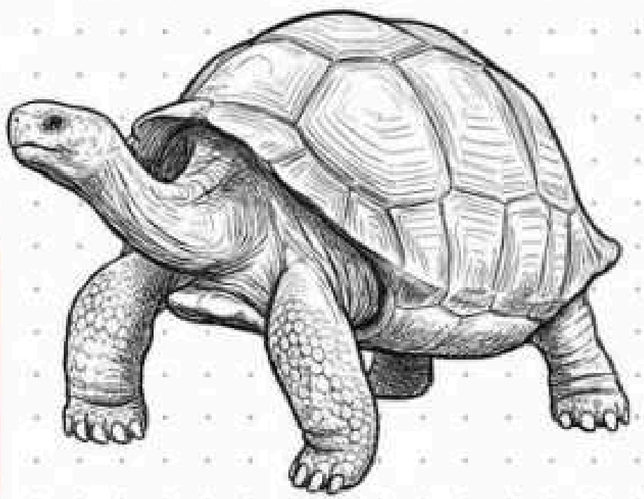
Mainland Ancestors
(South America)





Distinct yet Resembling Island Descendants
(Galápagos)

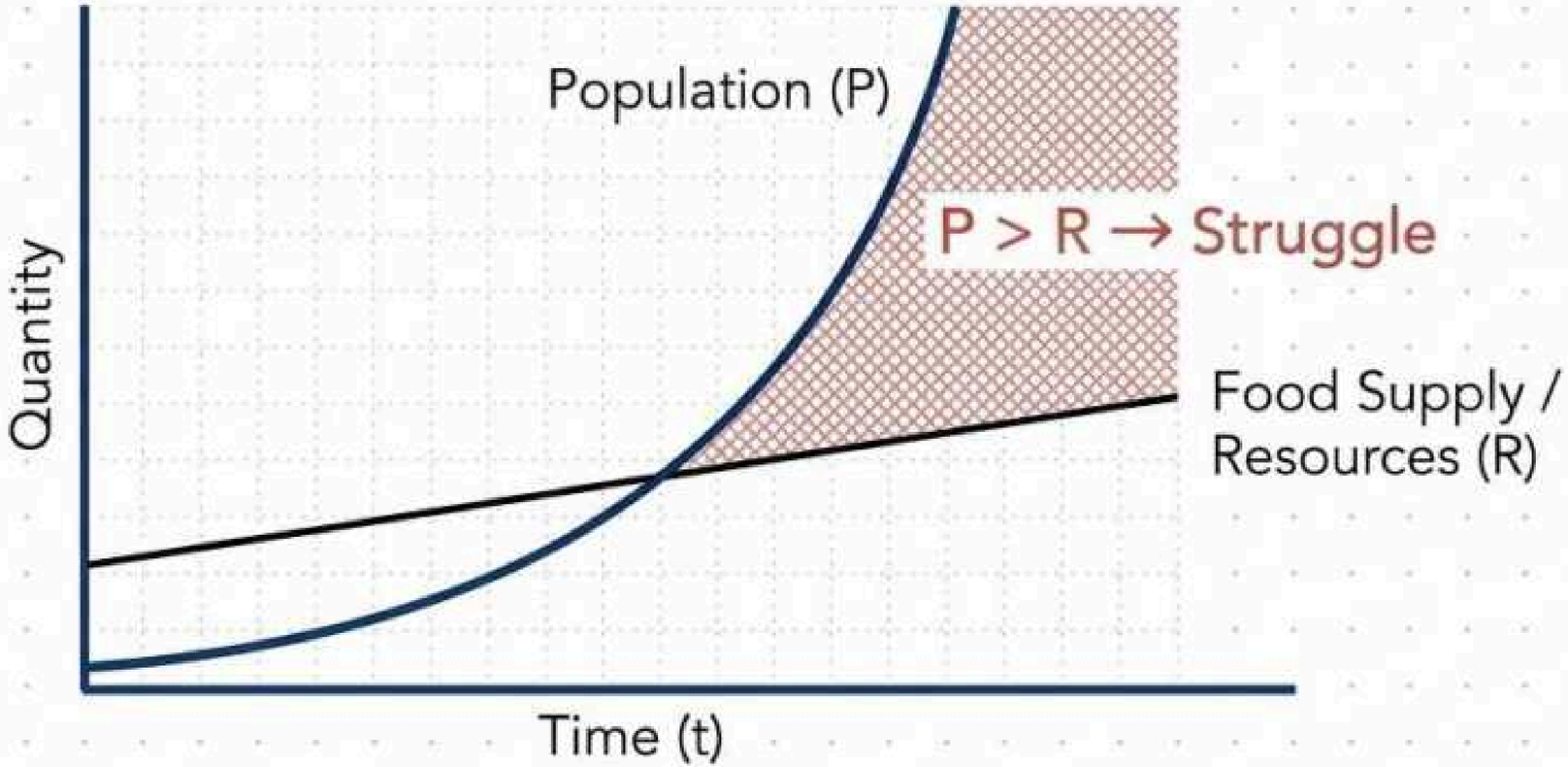




Species descended from common ancestors and changed as they spread to new isolated environments.

¶ 1.5

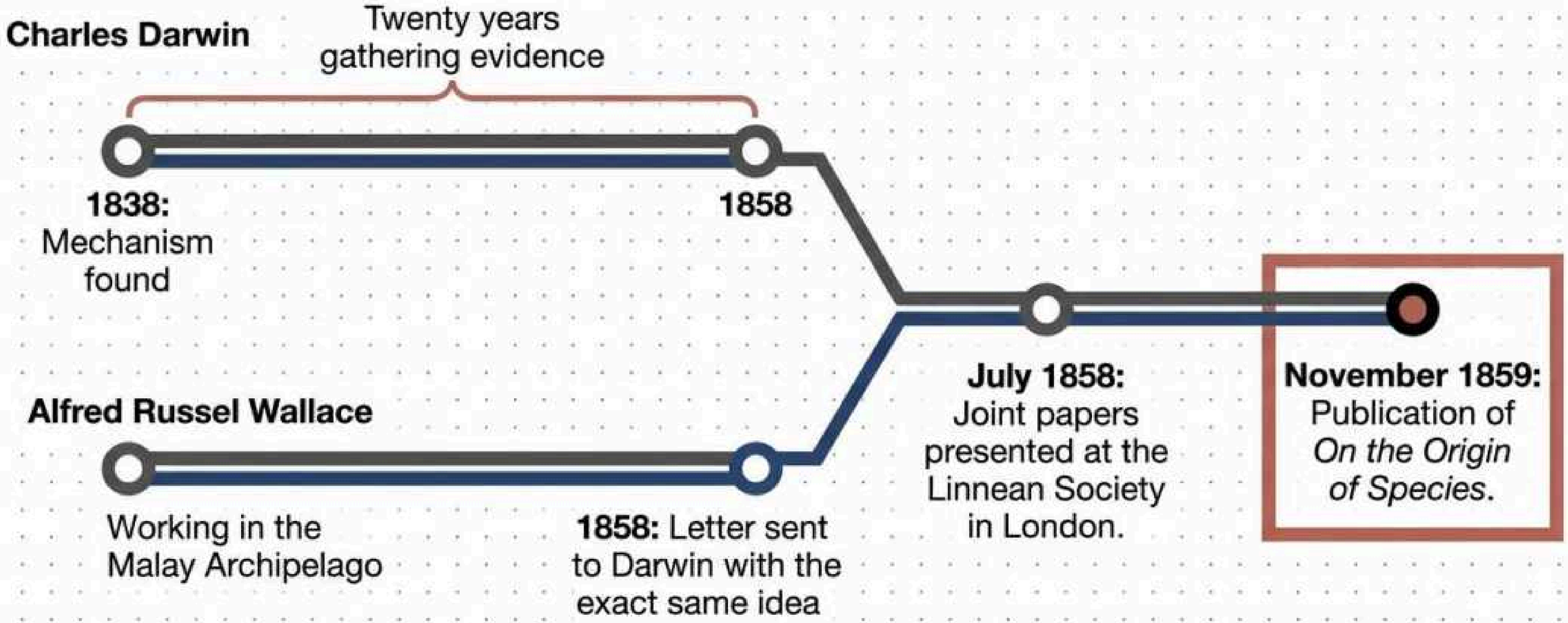
Malthusian scarcity provides the catalyst: the struggle for existence.



In this struggle:
- Favorable Variations → Survive & Reproduce
- Unfavorable Variations → Lost

¶ 1.6

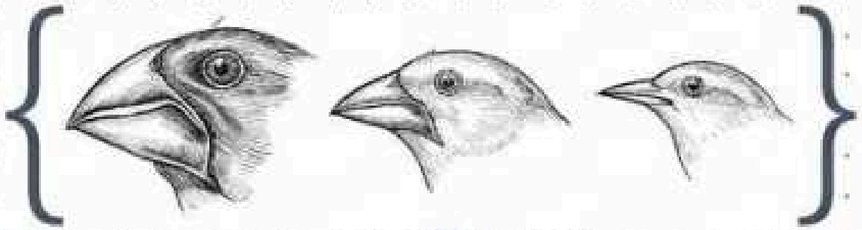
Two decades of evidence gathering converged with Wallace's independent discovery.



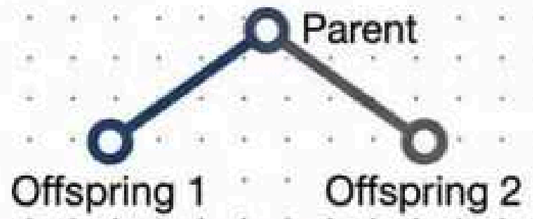
¶ 1.7

The four-part axiomatic logic of natural selection.

1. Variation: Individuals in a population vary.



2. Inheritance: Much of this variation is inherited.



3. Overproduction: More offspring are produced than can survive.

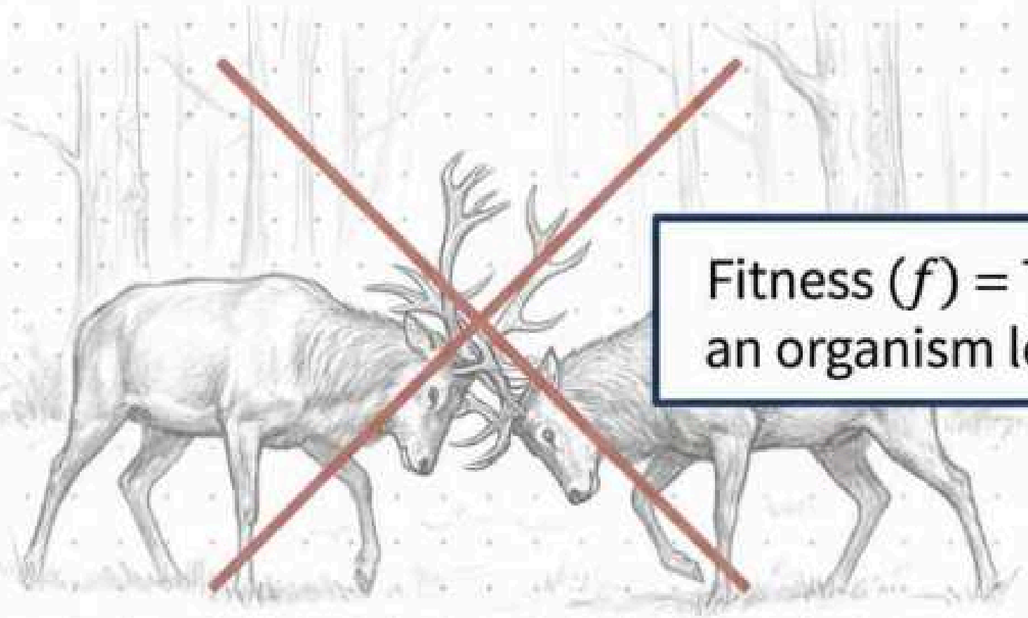
$P > R$

4. Differential Success: Traits that aid survival/reproduction become more common over generations.

Natural Selection is an inevitable algorithmic output when variation, heritability, and scarcity are present.

‘Survival of the fittest’ measures reproductive success, not physical strength.

Herbert Spencer’s colloquial phrasing



Biological Fitness



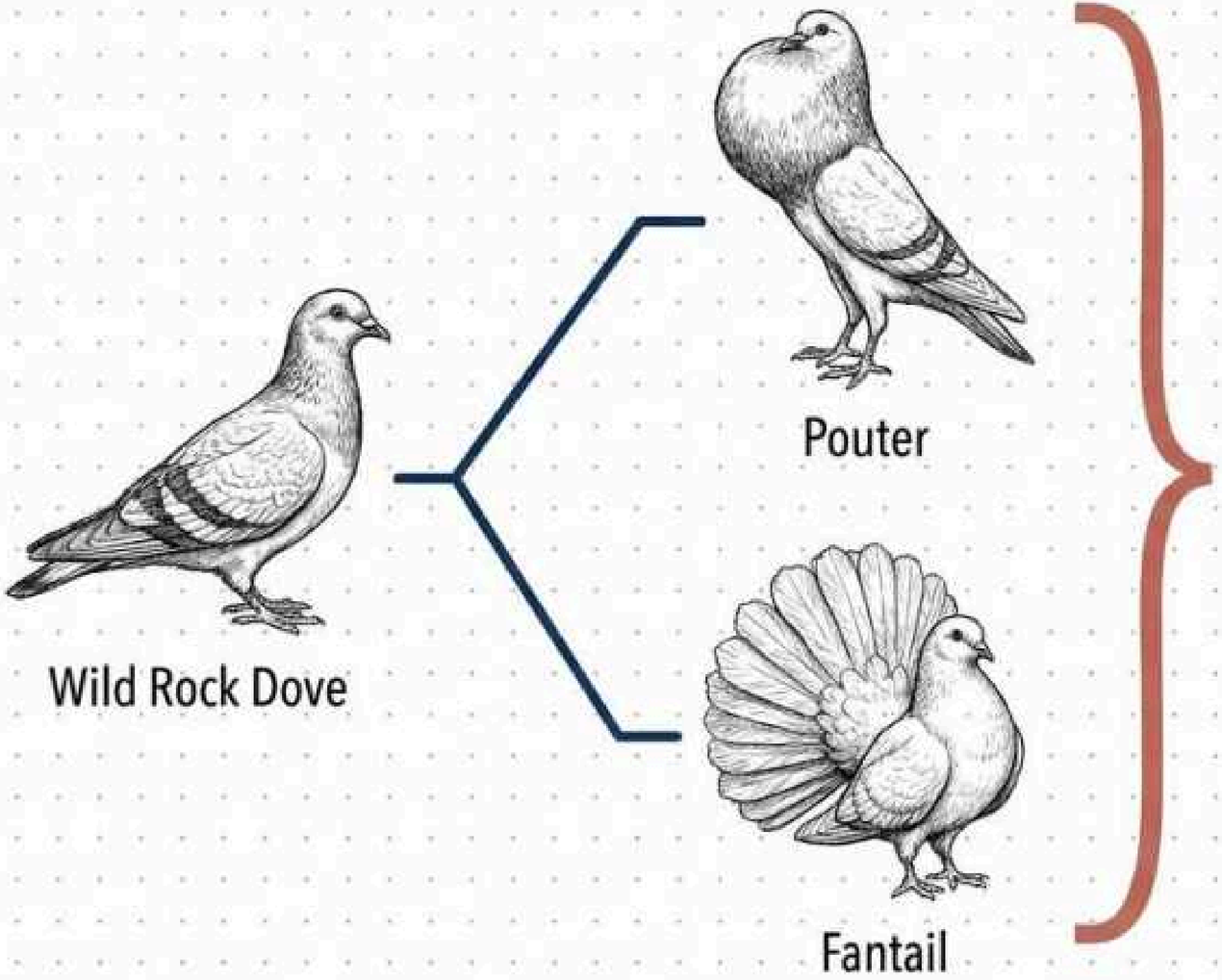


Fitness (f) = The number of offspring an organism leaves, relative to others.

Fitter = (Plant producing more seeds) OR (Bird attracting more mates).

Fitter ≠ simply stronger.

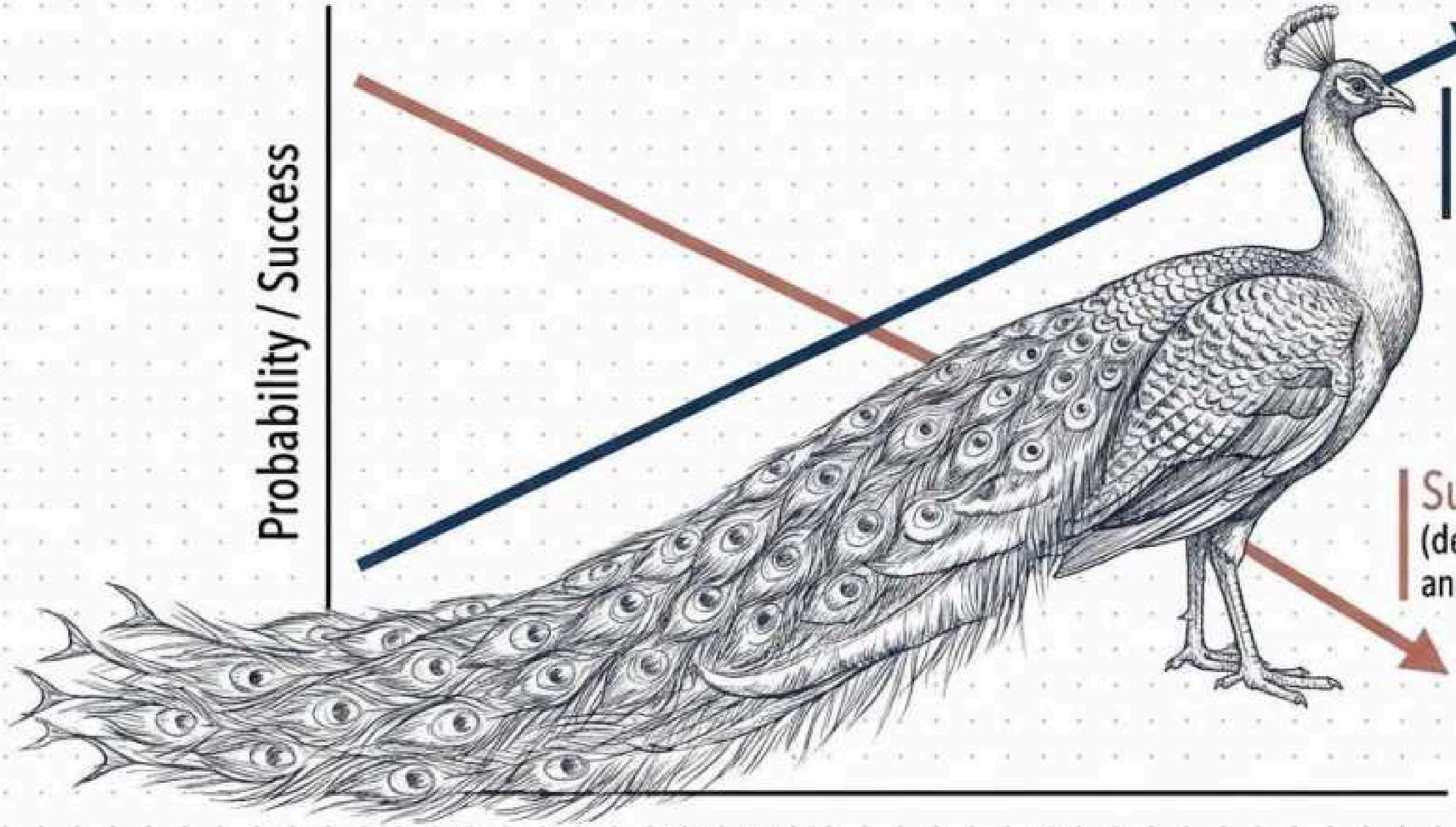
Artificial selection proves the plasticity of species.



[Human Selection] × [A few centuries]
= Radical domestic breeds.

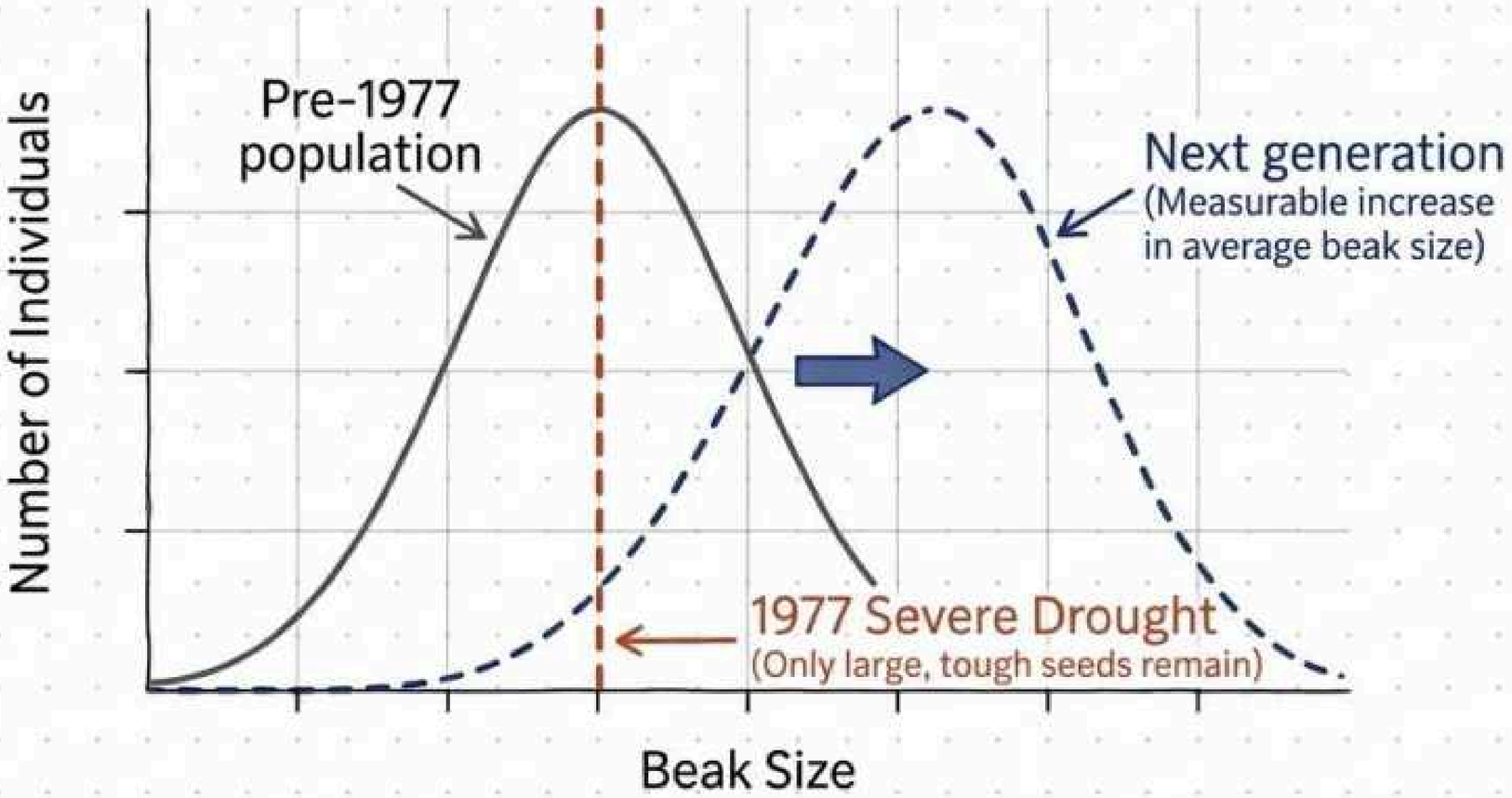
∴ [Natural Selection] × [Millions of years]
= Entirely new species.

Sexual selection: the trade-off between surviving and winning mates.



Other evolutionary trade-offs for mate attraction: Antlers, bright colors, birdsong.

Observable data I: Directional selection in Galápagos finches.

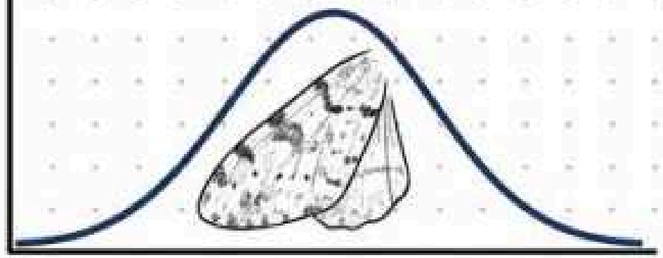


Peter and Rosemary Grant measured Daphne Major finches for decades starting in 1973, proving selection happens in real-time.

Observable data II: Reversible environmental pressures in Britain.

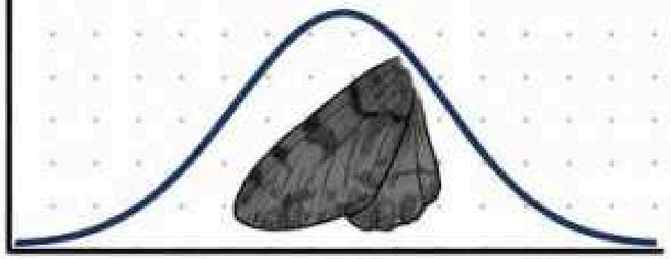
¶ 1.12

Pre-Industrial Revolution



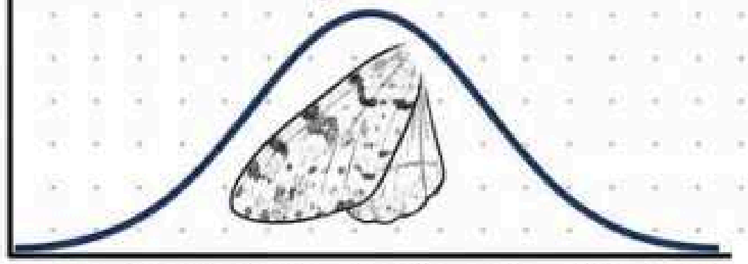
Moth Color (Pale to Dark)
(Camouflage against lichen)

Industrial Soot



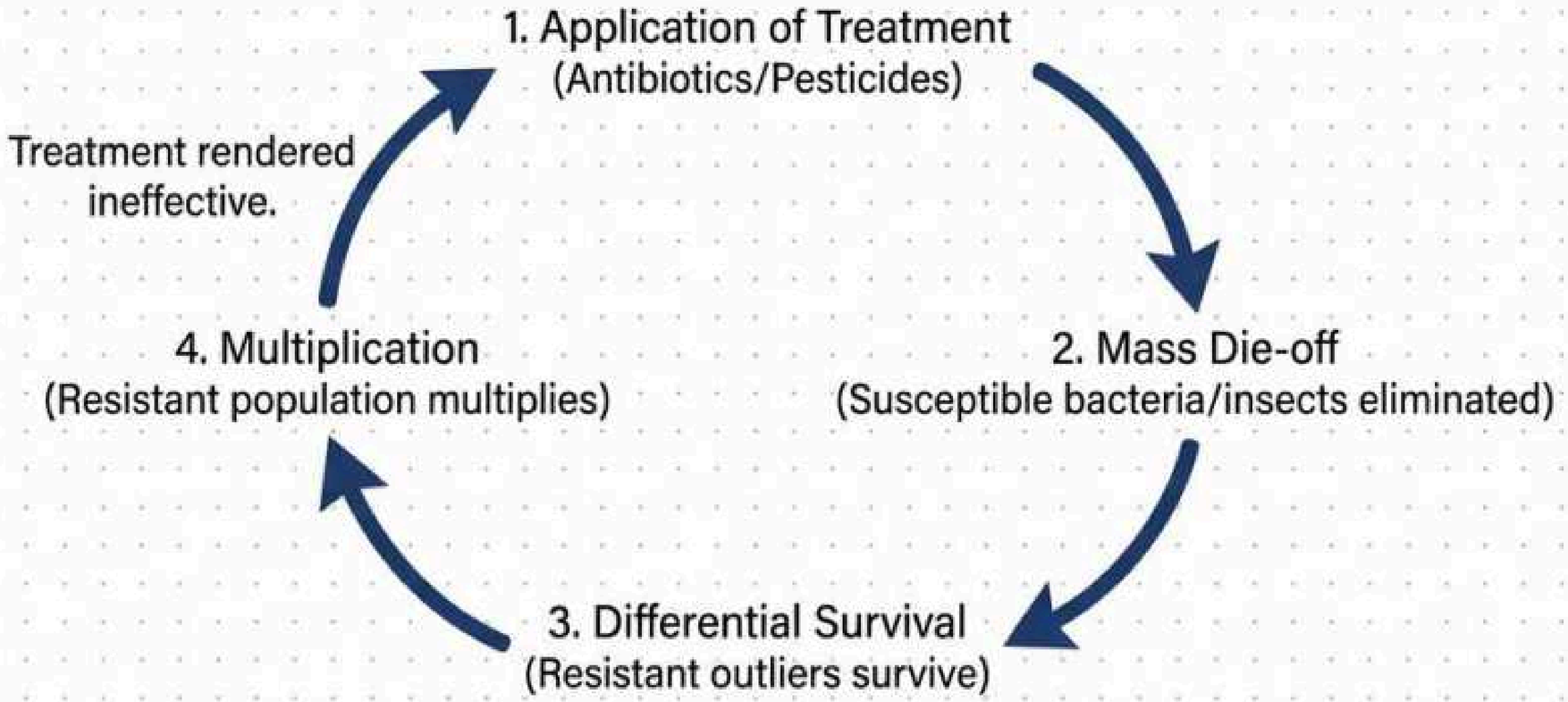
Moth Color (Pale to Dark)
(Pale moths eaten by birds)

20th Century Clean Air Laws



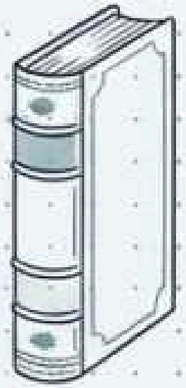
Moth Color (Pale to Dark)

Modern impact: The ongoing evolution of antimicrobial resistance.



The World Health Organization (WHO) identifies antimicrobial resistance as one of the greatest threats to global health.

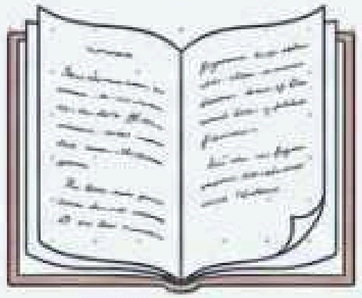
Foundational texts and modern chronicles of evolutionary biology.



On the Origin of Species

Charles Darwin

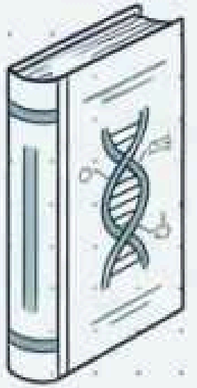
The foundational text; chapters 1-4 highly recommended.



The Beak of the Finch

Jonathan Weiner (1994)

Pulitzer Prize-winning chronicle of the Grants' decades of research.



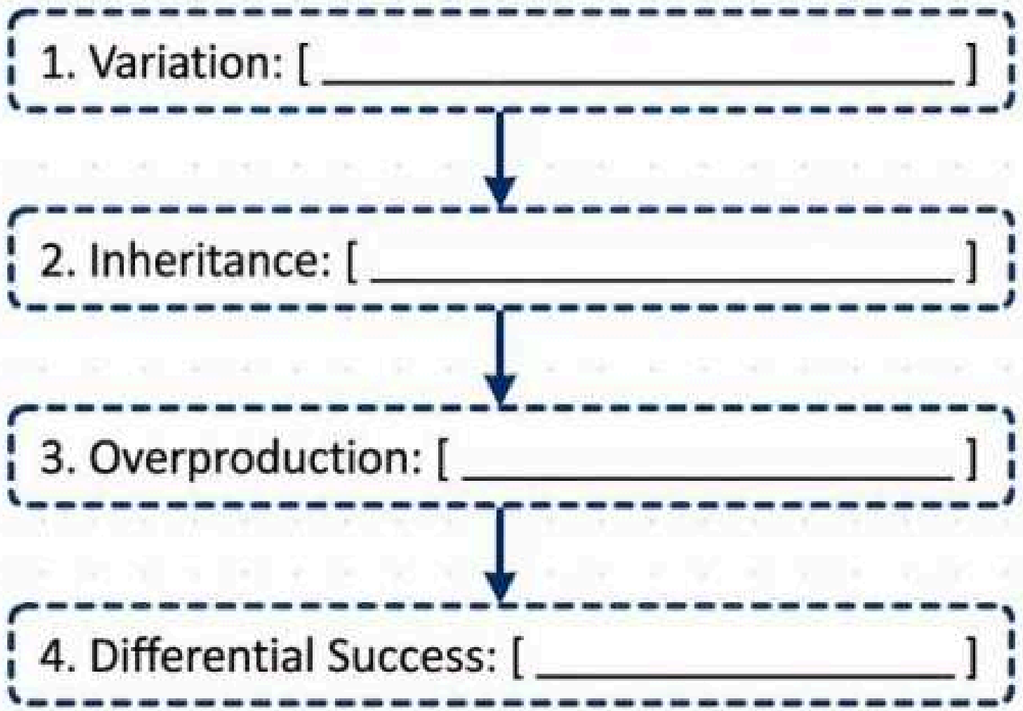
Why Evolution Is True

Jerry Coyne (2009)

A comprehensive summary of modern evolutionary evidence.

Closing exercise: Applying the algorithmic logic of selection.

Choose an animal you know well. Identify one trait that aids survival or reproduction. Map it through the four steps:



In Lecture Two, we turn to the molecular mechanism underlying inheritance: Genes.