

What is evolution?

Evolution is change in the gene pool of a population over time

Gene: hereditary unit passed on unaltered for many generations

Gene pool: set of all genes in a species or population

Population: a group of individuals of one species living in a particular geographic area

I will illustrate what is evolution using data of Peter Grant and Rosemary Grant, two scientists from Princeton University who have been studying finches in the Galapagos Islands for about 30 years.



Rosemary
Grant

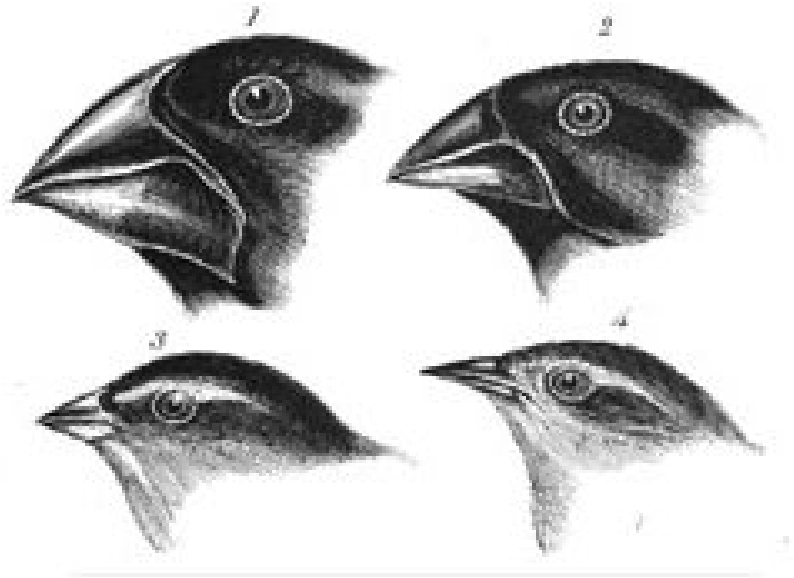


Peter
Grant

Galapagos Islands

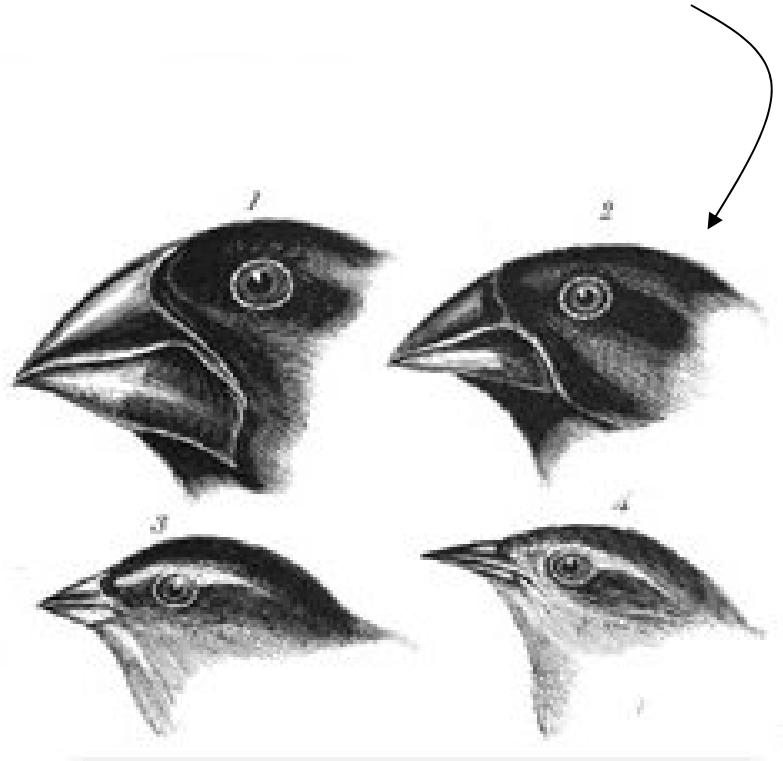


Several of the main traits that the Grants have studied are beak size and shape. Beaks are important tools for the birds and the size and shape of the beak affects what seeds they eat and how well they handle them.

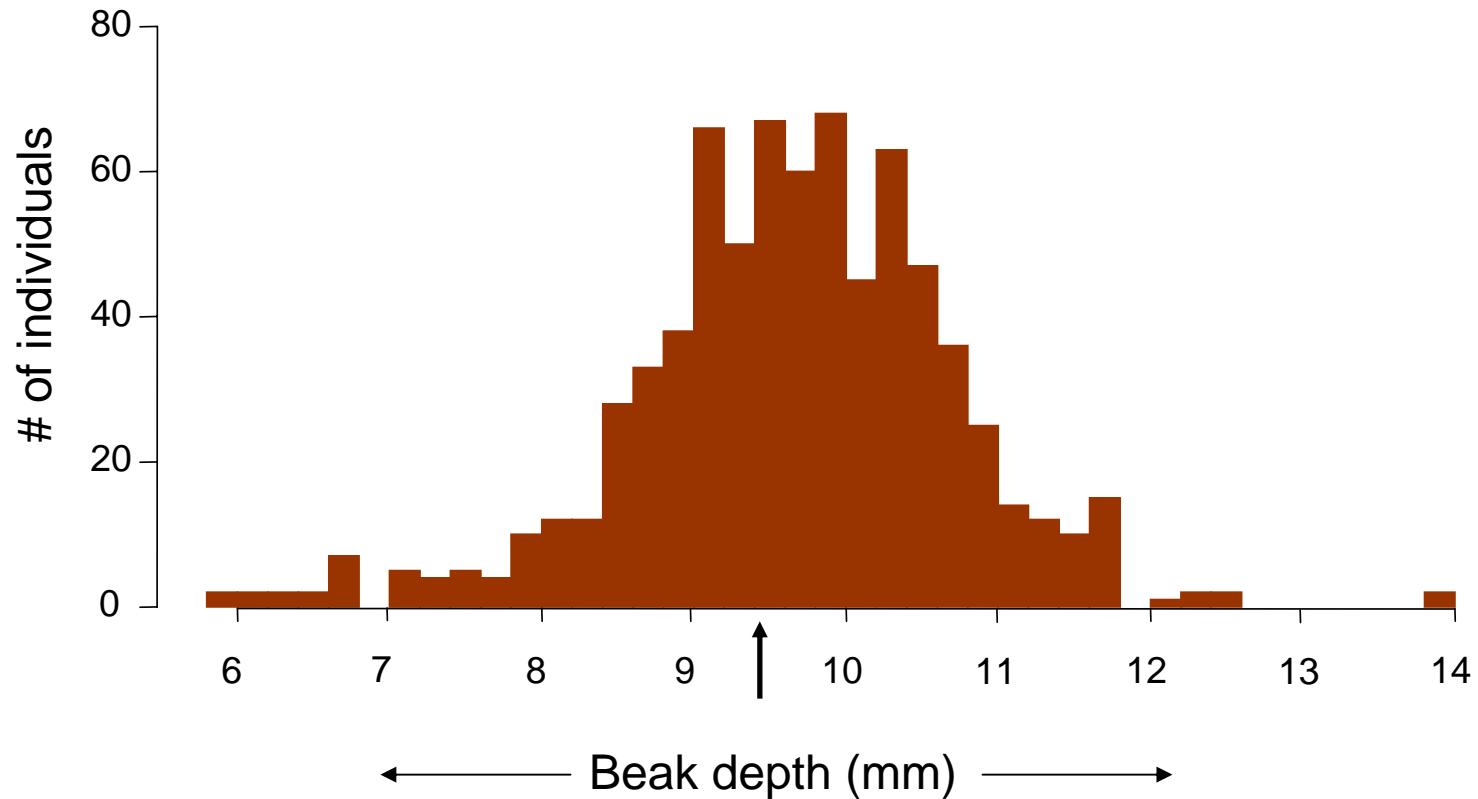


This picture is from Darwin's book, *The Voyage of the Beagle*

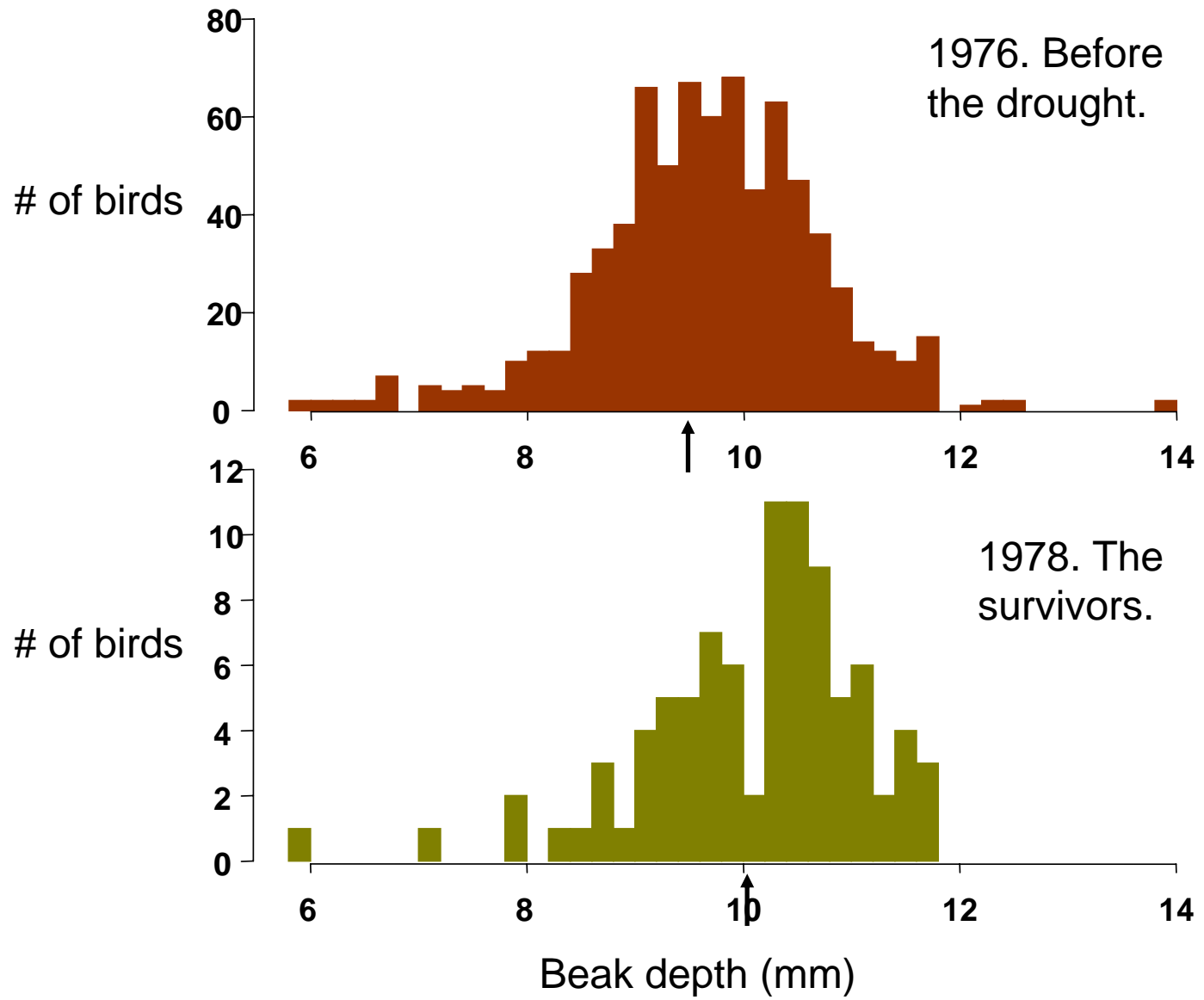
The main species that the Grants have studied on Daphne Major is the medium ground finch (*Geospiza fortis*)



This graph is a histogram of beak depth in 751 individual medium ground finches on Daphne Major in 1976. The arrow points to the average value.



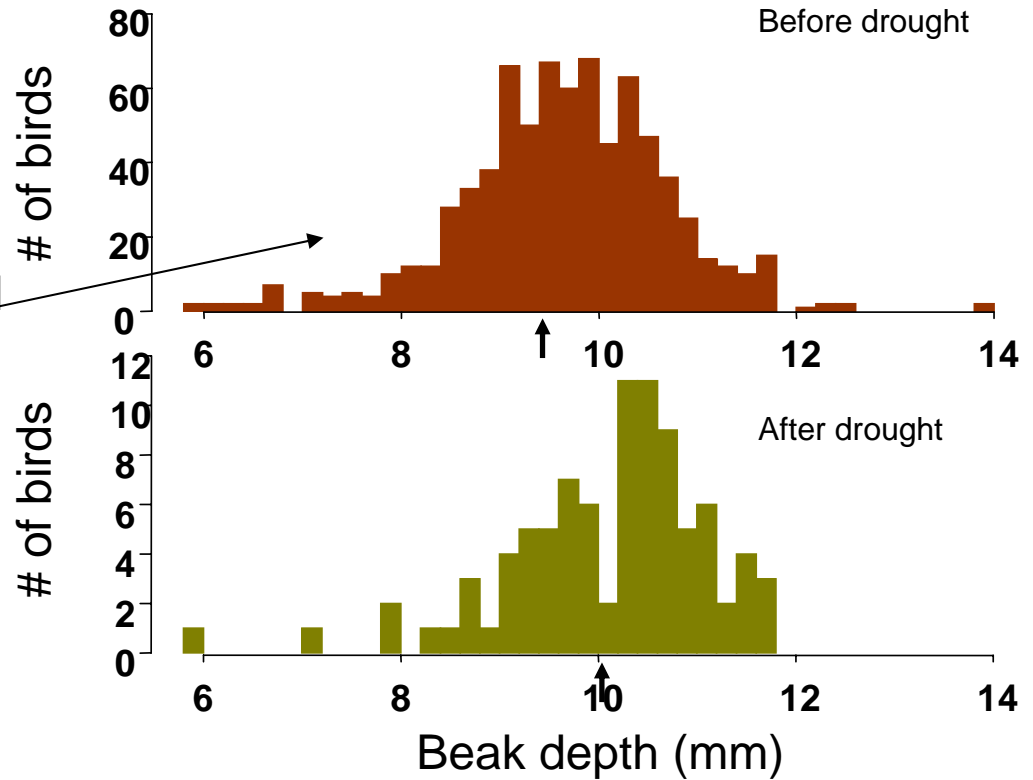
The average beak depth increased after a drastic drought hit the population



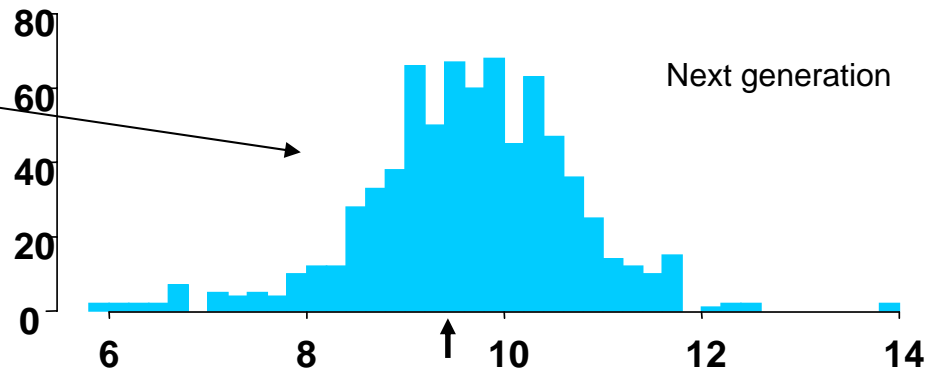
Does this imply evolution has occurred?

Which information is further needed in the case study just presented in order to suggest evolution has happened?

Finches with large beaks could have been favored even if all the variation in the original population had been environmental (none of it due to genes).



But if so, no evolution would have occurred—and the next generation might have had the same mean beak depth as the original population.

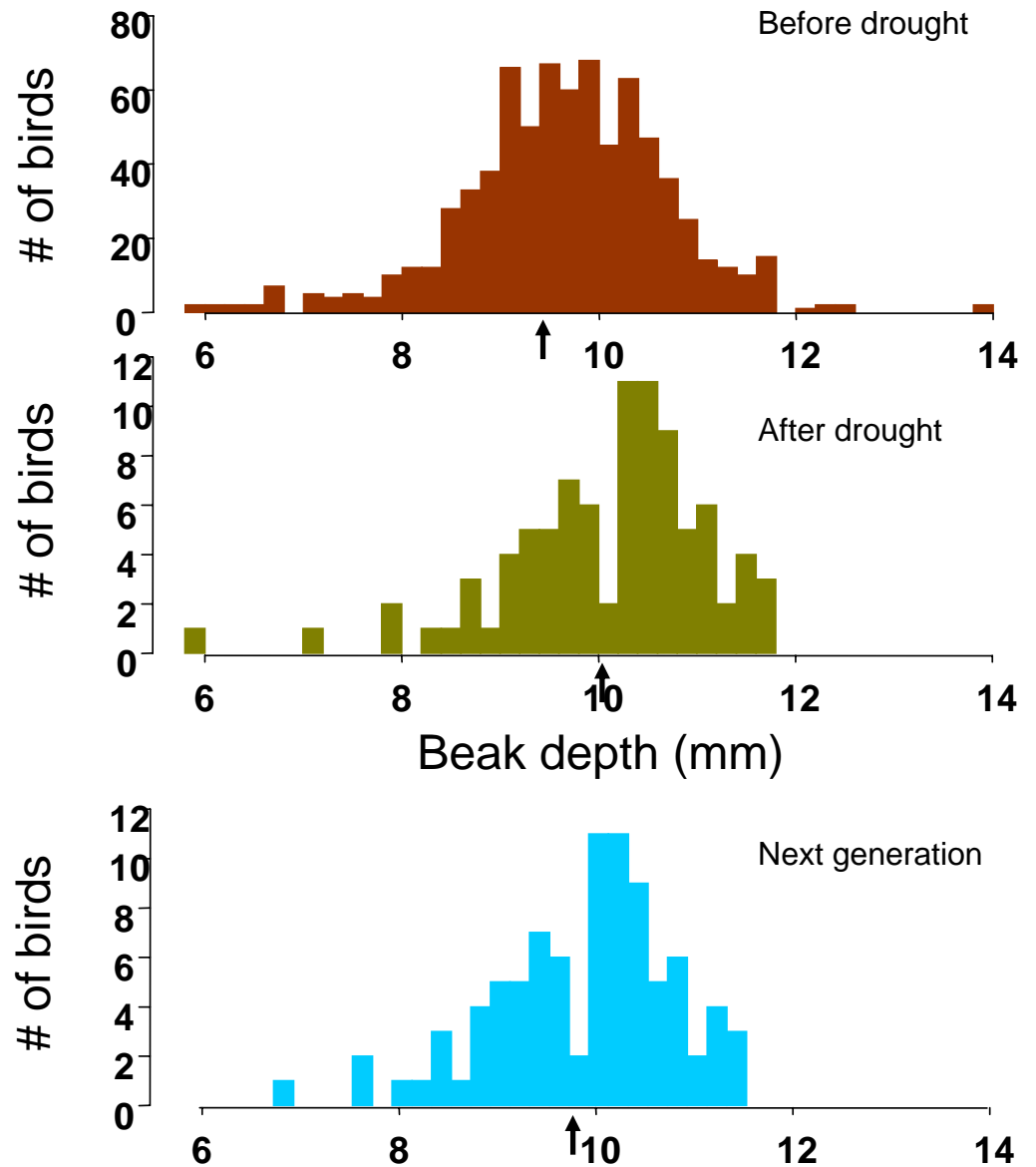


How do we know change in beak depth is due to change in the gene pool?

In other words how do we know the variation in beak depth is mainly due to genetic variation rather than environmental variation?

Evolution occurs only if the *heritability* of the trait is greater than zero—that is, some of the variation in the original population is due to variation in the genes.

If so, then the average beak depth of the next generation will shift in the direction of the remaining population after the drought

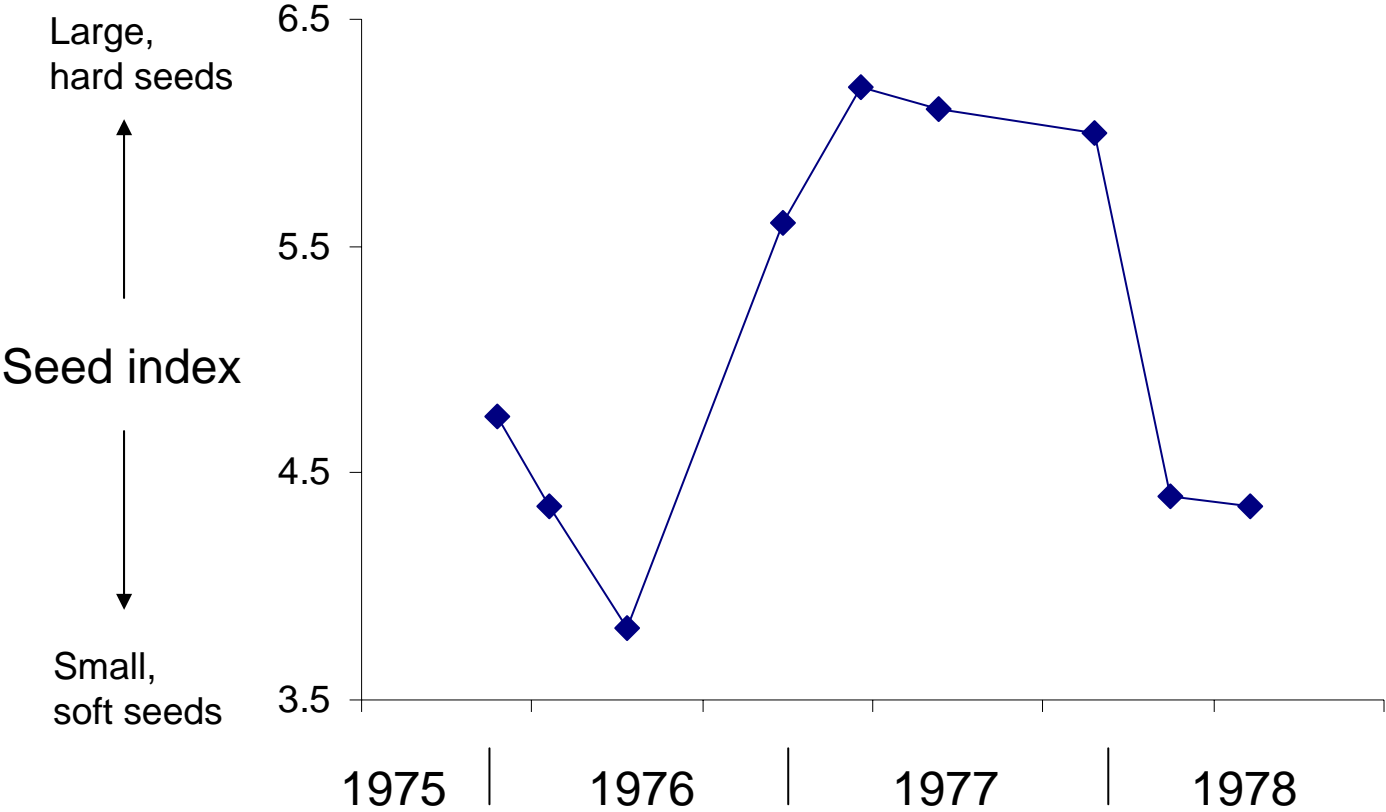


What actually happened?

	<u>Mean beak depth (mm)</u>
1976. Before the drought	9.4
1978. After the drought	10.1
1978. Next generation	9.7

→ Beak depth has evolved

Probable cause of evolution on beak depth: changes during the drought in seed size and hardness. As a result more birds with larger beak depths survived until reproductive age and left offspring



Hence evolution by natural selection occurred in the *G. fortis* population

Natural selection: differential reproductive success of pre-existing classes of genetic variants in the gene pool; only mechanism of adaptive evolution

Which unit evolves: the individual or the population?

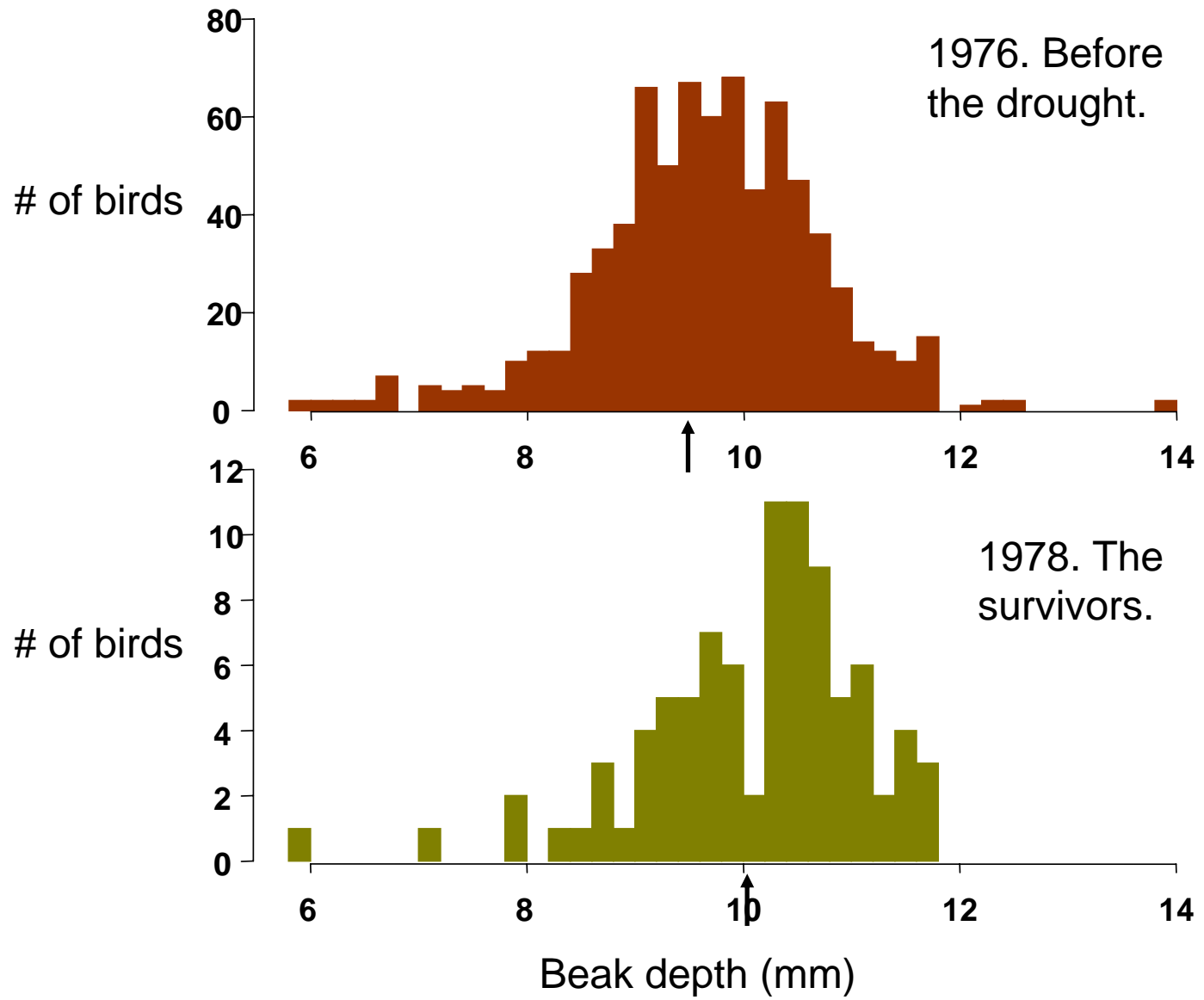
Which unit evolves: the individual or the population?

The population

View populations as a collection of individuals, each individual harboring a different set of traits. Individuals do not evolve, they die out of the population taking with them their specific genes



In our *Geospiza fortis* example:



Microevolution: evolution occurring at the level of populations. Think of it as vertical change in the same species

Macroevolution: evolution involving larger changes, such as when a new species is formed. This involves vertical change plus branching: new species

Common misconceptions about evolution

- *Evolution can occur without morphological change* –e.g. behavioral change– *and morphological change can occur without evolution* – phenotypic changes due to changes in environment

Phenotype: morphological, physiological, biochemical, behavioral and other properties exhibited by a living organism

-*Evolution is not progress.* Populations simply adapt to their current surroundings. They do not necessarily become better in any absolute sense over time.

-*Organisms are not passive targets of their environment.* Each species modifies its own environment

Genetic variation

Evolution requires genetic variation. Mutations –random changes in a gene – and sexual recombination – shuffling of alleles during meiosis-- create variation in the gene pool of a population.

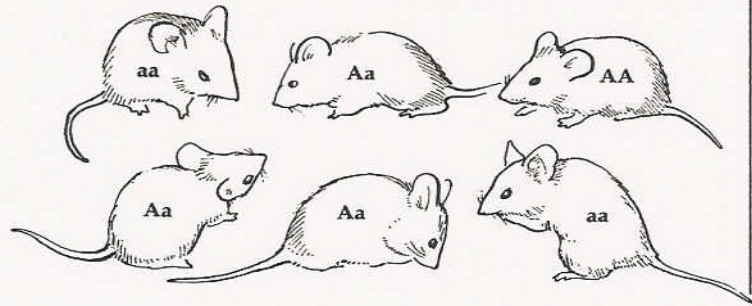
Mutations are the ultimate generators of genetic diversity as they originate new alleles

Genetic variation has two components: allelic diversity and non-random associations of alleles

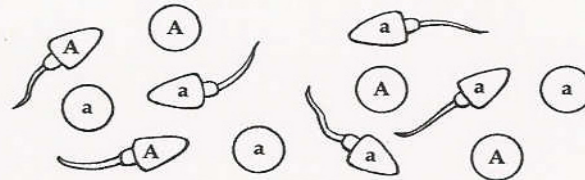
- Alleles are different versions of the same gene*
- Locus is the location of a gene in a chromosome*
- Diploid individuals with two alleles at every locus*
- Homozygous: individuals whose two alleles are the same type*
- Heterozygous: individuals whose two alleles are different*

At any locus there can be many different alleles in a population. Example: Blood group in humans: A, B, O

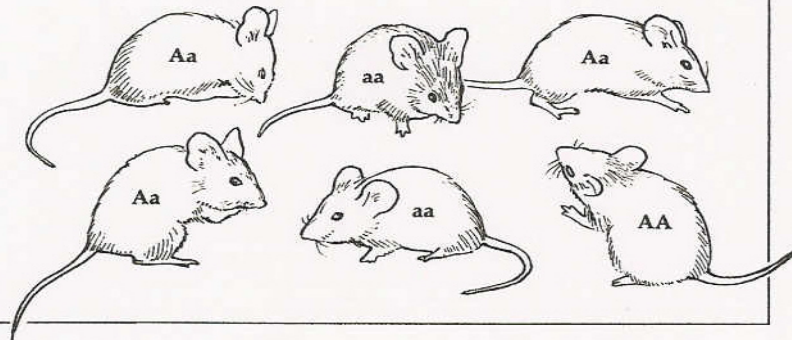
Diploid organisms



Sex cells



Diploid organisms



Non random associations of alleles can be the result of:

Linkage disequilibrium – association between alleles at different loci –

For example in the moth *Papilio memnon* there is an association between the gene that determines wing morphology and the one that determines wing color

Assortative mating – non random mating that causes a shift in the distribution of alleles at a single locus

For example humans mate assortatively according to race; in populations that mate this way, fewer heterozygous are found than would be predicted under random mating