Quantitative characters III: evolution in nature

Selection occurs whenever there is a nonrandom relationship between phenotypes (performances) and fitnesses.

But *evolution* occurs only when there is heritable (additive) variation for the phenotypes.

The *rate* of evolutionary change depends on the *strength* of selection and the *amount* of additive genetic variation.

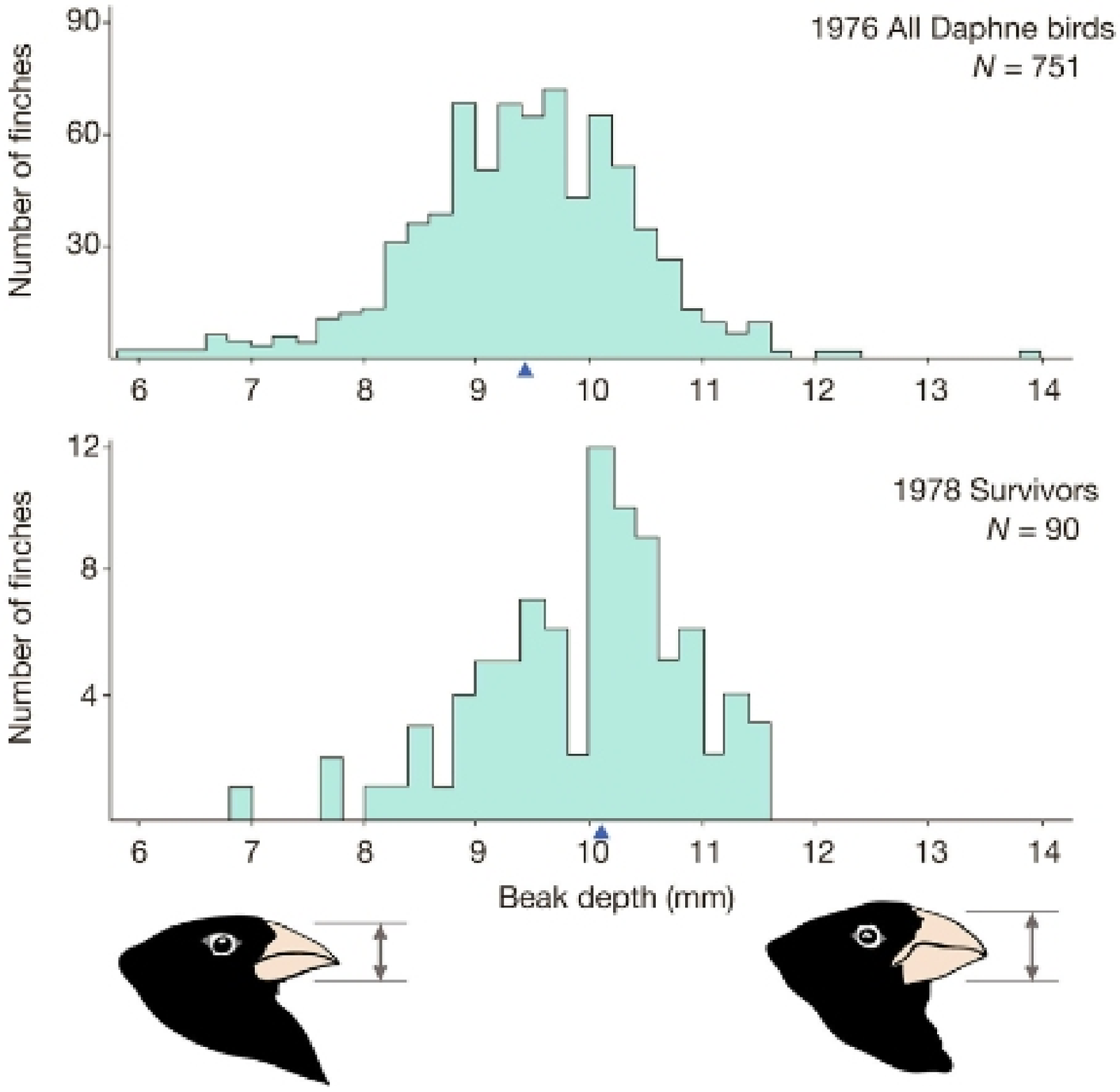
For directional selection, there are two equivalent ways to represent this relationship:

$R = h^2 S$

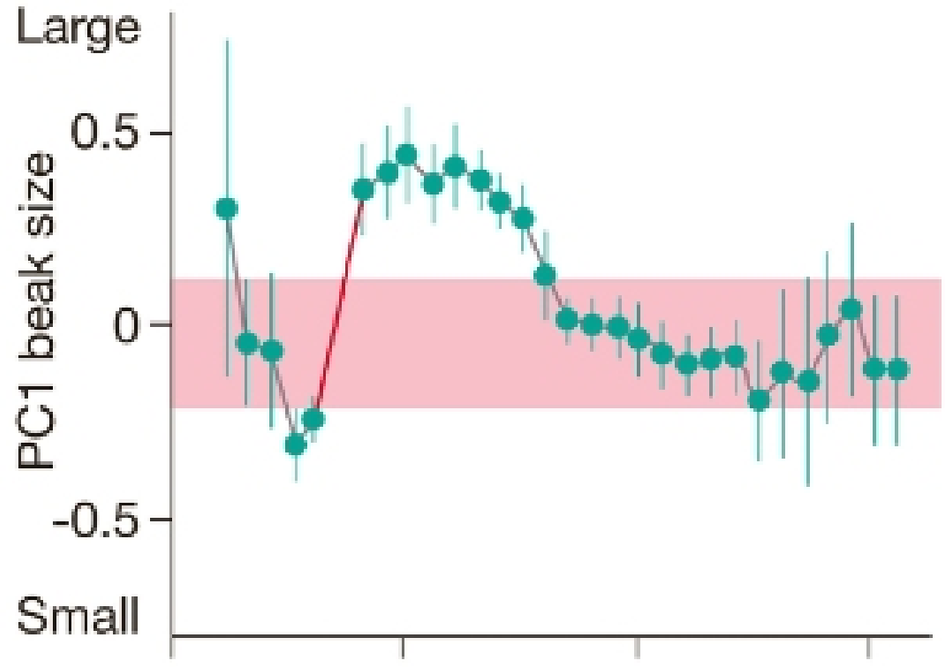
(response = heritability x selection differential)

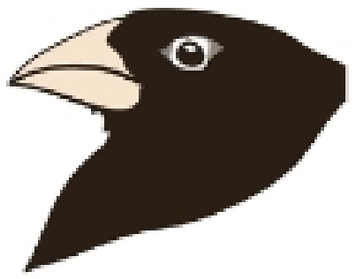
$\Delta x = V_A \beta$

(change = additive variance x selection gradient)

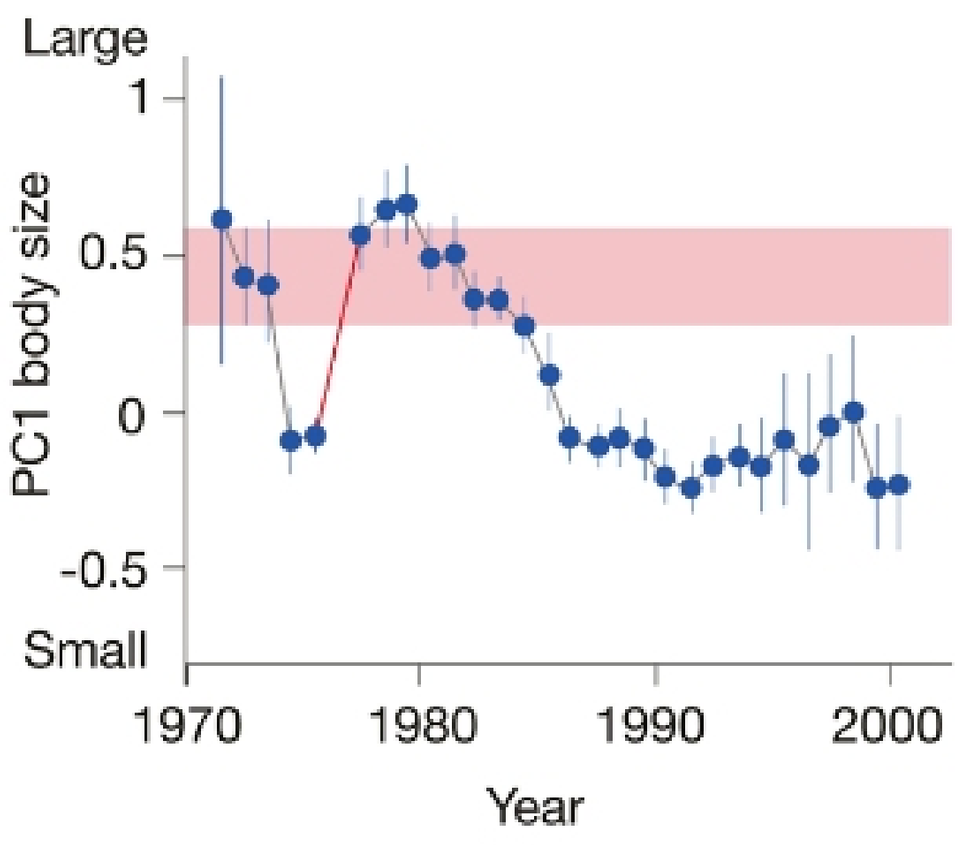


Some quantitative traits have been observed to evolve very rapidly.
For example: beak and body sizes of *Geospiza fortis* on Isla Daphne Major





Beak size and body size increase dramatically in response to the drought of 1977, but both then decrease slowly.



Adaptation to a tradeoff:
Larger beaks and bodies are favored when most seeds are large and hard;
smaller beaks and bodies are favored when most seeds are small and soft.

S and *β* quantify the strength of selection

S (the selection *differential*) is the *difference* between the mean phenotype of the reproductively successful parents and the whole population (of *potential* parents).

B (the selection *gradient*) is the *slope* of the regression describing the relationship between *fitness* (*y*) and values of the phenotype (*x*), when mean fitness is normalized to 1.