Administrative business

- Midterm:

  - Wednesday Nov 1 (NOT Nov 3 as stated in previous version of slides!)
  - Please bring a calculator that can do square roots
  - A copy of the equation sheet is on the web site (this will be attached to the exam for your use)

- No new homework assignment this week due to exam; work on the practice problems instead

- Please come with questions/problems on Monday for the review session

Overview

- Kin selection vs. group selection

- Quantitative variation:

  – What is a quantitative trait? What are the underlying
     genetics?
  – Mean and standard deviation
  – Response to selection
  – Artificial selection experiments

One minute responses

- How does calculating r change for sex-link traits?

  – For Y-linked traits, male is 100% related to his father and sons, and 0% to his mother and daughters
  – mtDNA traits work same way for females
  – Try working out an X-linked trait to see how it behaves

- Can shared r be calculated using multiple siblings?

  – I'd calculate r for each individual, then add benefits together
 – Helping 10 siblings is 10x as good as helping one!

One minute responses

- Q: Could the ground squirrel lack of male cooperation have to do with sex? With sex linkage?

- A: Maybe?

  – Which sex moves to new groups in this species? (The sex that moves will have fewer relatives locally)
  – How much information do males vs. females have about who their relatives are?

- Most sex-affected traits are not actually sex-linked, though it's possible

Group selection without kin selection

- *Dictyostelium discoides* may be an example

- Free-living amoeba band together to form fruiting bodies

- There is no apparent preference to band with kin
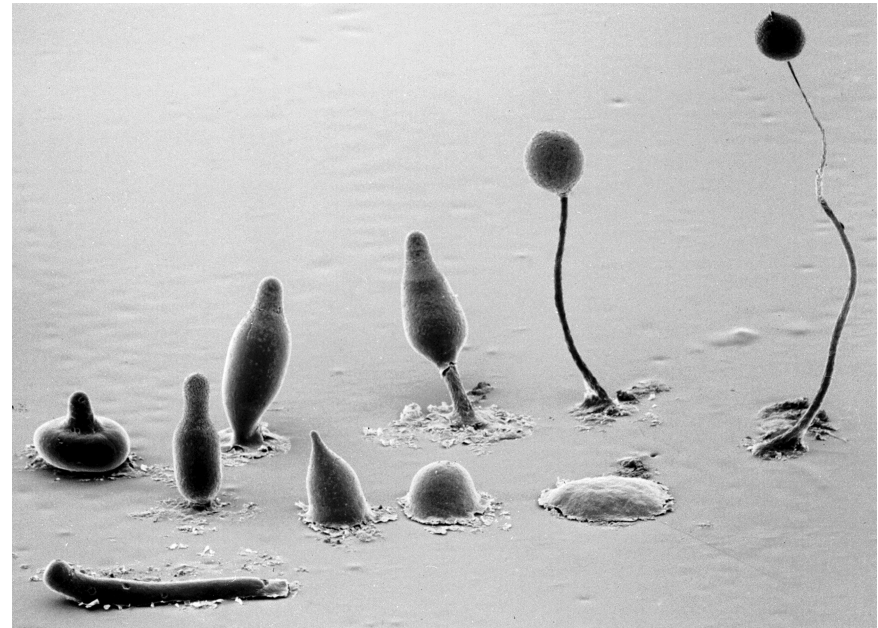
Copyright, M.J. Grimson and R. L. Blanton, Biological Sciences Electron Microscopy Laboratory, Texas Tech University

The "greenbeard" effect

- Richard Dawkins coined the name "greenbeard" for a gene that can:

  - Produce a distinctive phenotype
  - Allow its possessor to recognize that phenotype
  - Cause its possessor to behave altruistically toward those who share the phenotype

- Such a gene could spread in a population

The "greenbeard" effect

- $csA+$ individuals adhere better

- They tend to altruistically end up in the stem, not the fruiting body

- However, they recognize each other and drag each other into the slug!

- A slug from a 50/50 mix of $csA+$ and $csA-$ will produce spores that are 82% $csA+$

- The $csA-$ cells preferentially end up in the fruiting body, but only if they can get into the slug in the first place

Conclusions: kin selection vs. group selection

- Kin selection is pervasive in many organisms

- Group selection:

  - Requires unrelated groups to form
  - Is substantially weaker than kin selection
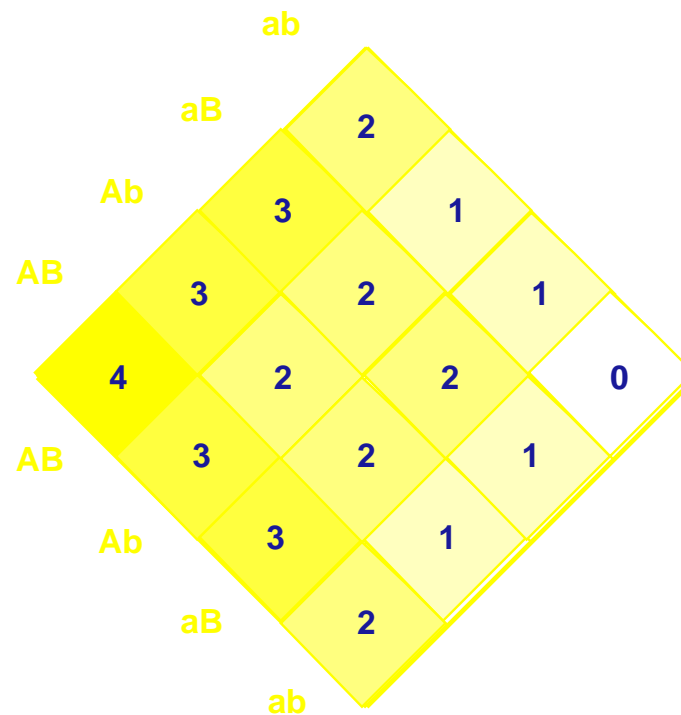 - Almost surely occurs $(Dictyostelium)$ but is probably rare
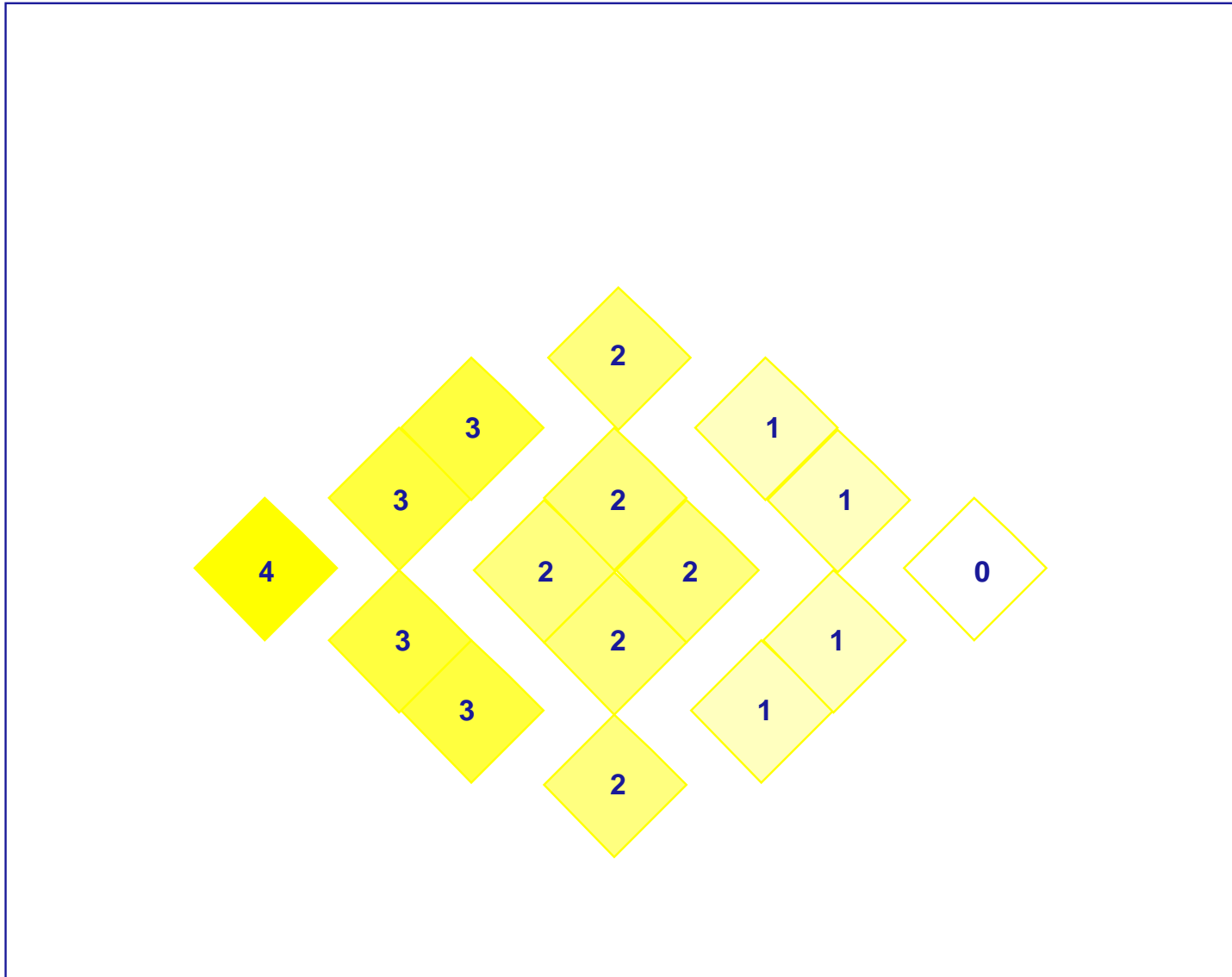
Examples of quantitative traits
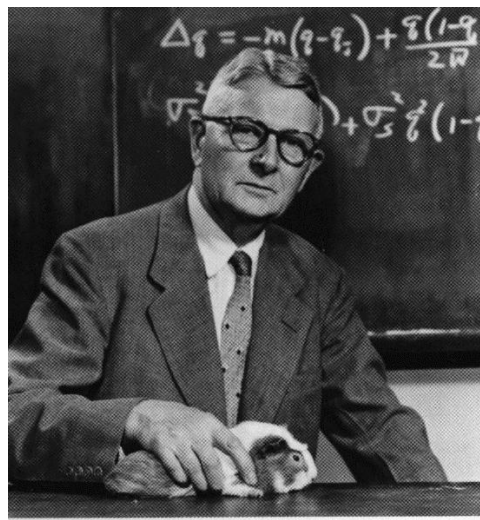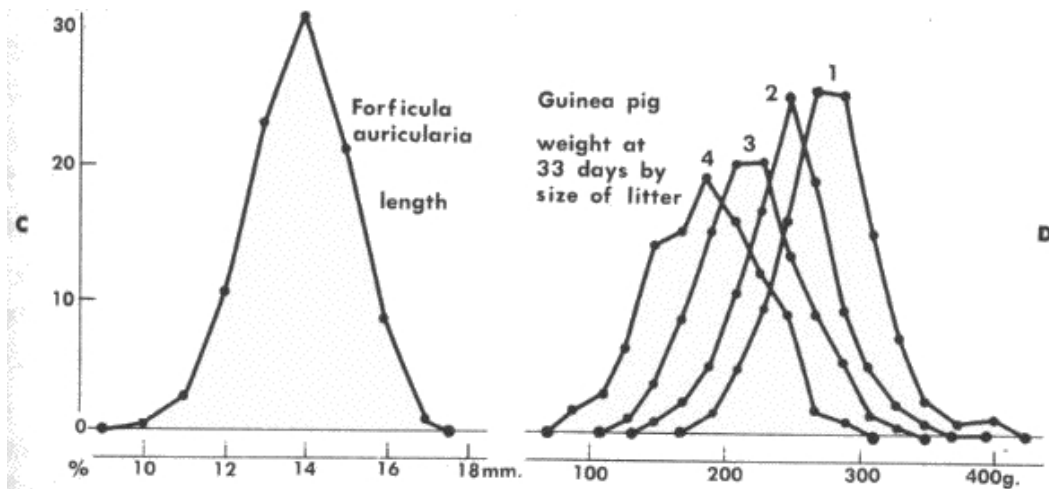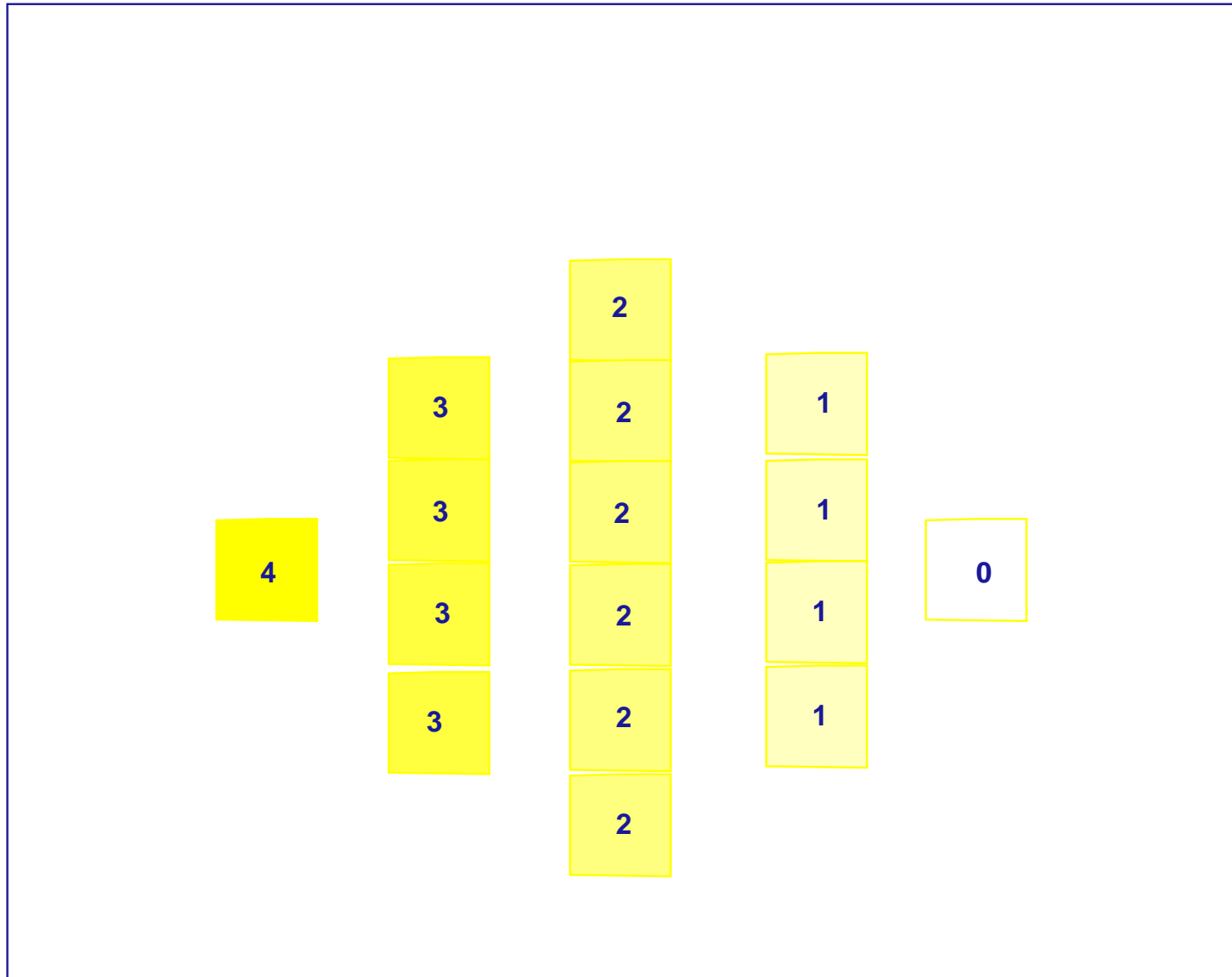
Multiple Mendelian characters → a quantitative trait

A random–mating population with two genes having
2 alleles each, at equal frequencies, symmetrically
affecting a quantitative character

Multiple Mendelian characters → a quantitative trait

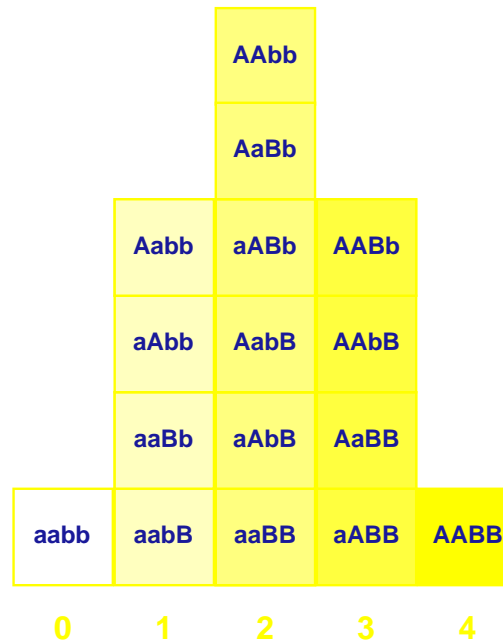# Multiple Mendelian characters → a quantitative trait

Multiple Mendelian characters → a quantitative trait
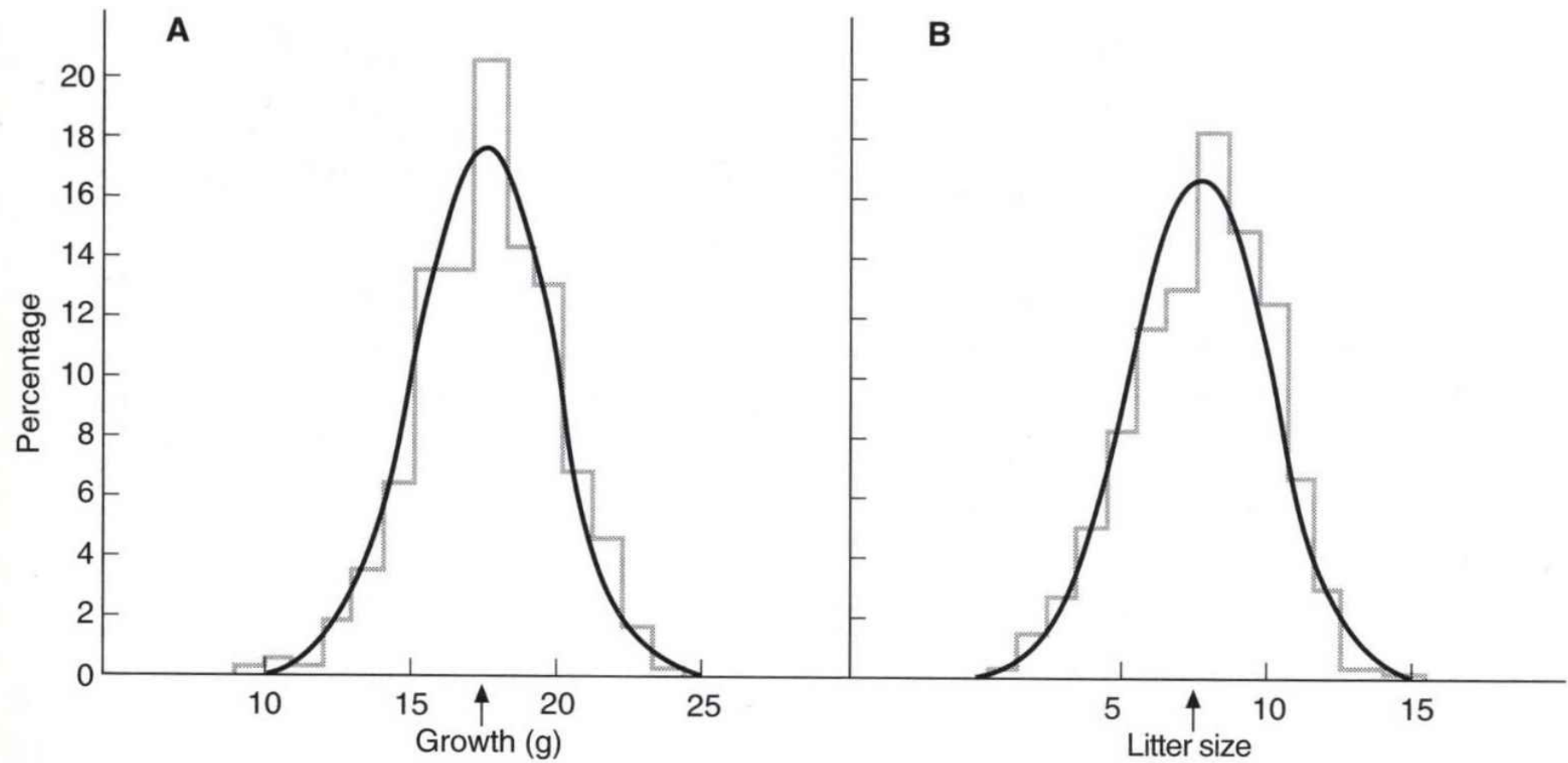

The distribution of the genotypes and the quantitative character before artificial selection

Examples of quantitative traits

Artificial selection

Before selection
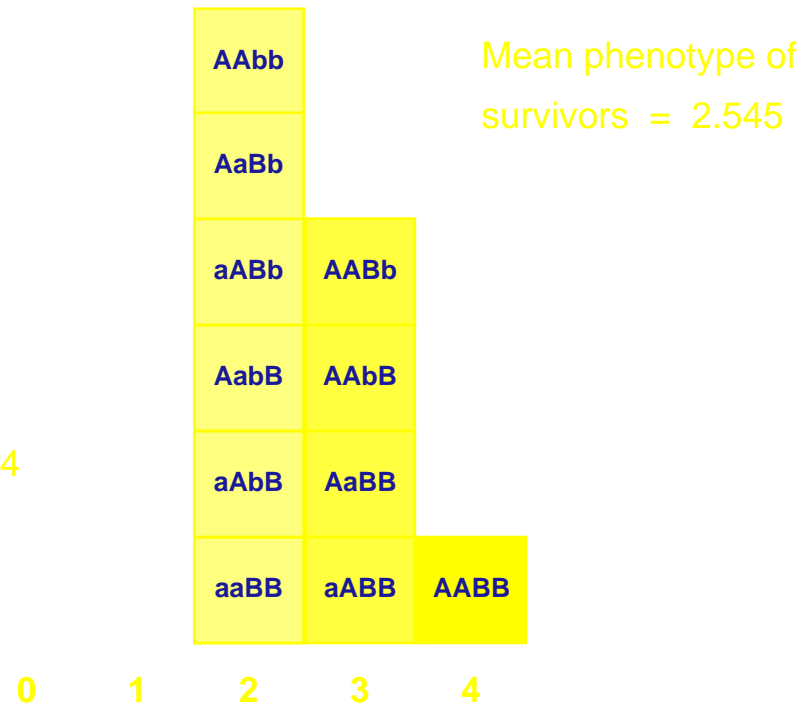
frequency of A = 0.5

frequency of B = 0.5

After selection:

frequency of A = 14/22 = 0.6364

frequency of B = 14/22 = 0.6364

		AAbb		
		AaBb		
		aABb	AABb	
		AabB	AAbB	
		aAbB	AaBB	
		aaBB	aABB	AABB
0	1	2	3	4

Mean phenotype of
survivors = 2.545

15

Distribution of trait in offspring

In fact, the offspring will have this distribution:

Mean phenotype
of offspring = 2.545

(484 copies in all)

180

154

81

60

9

0   1   2   3   4

16
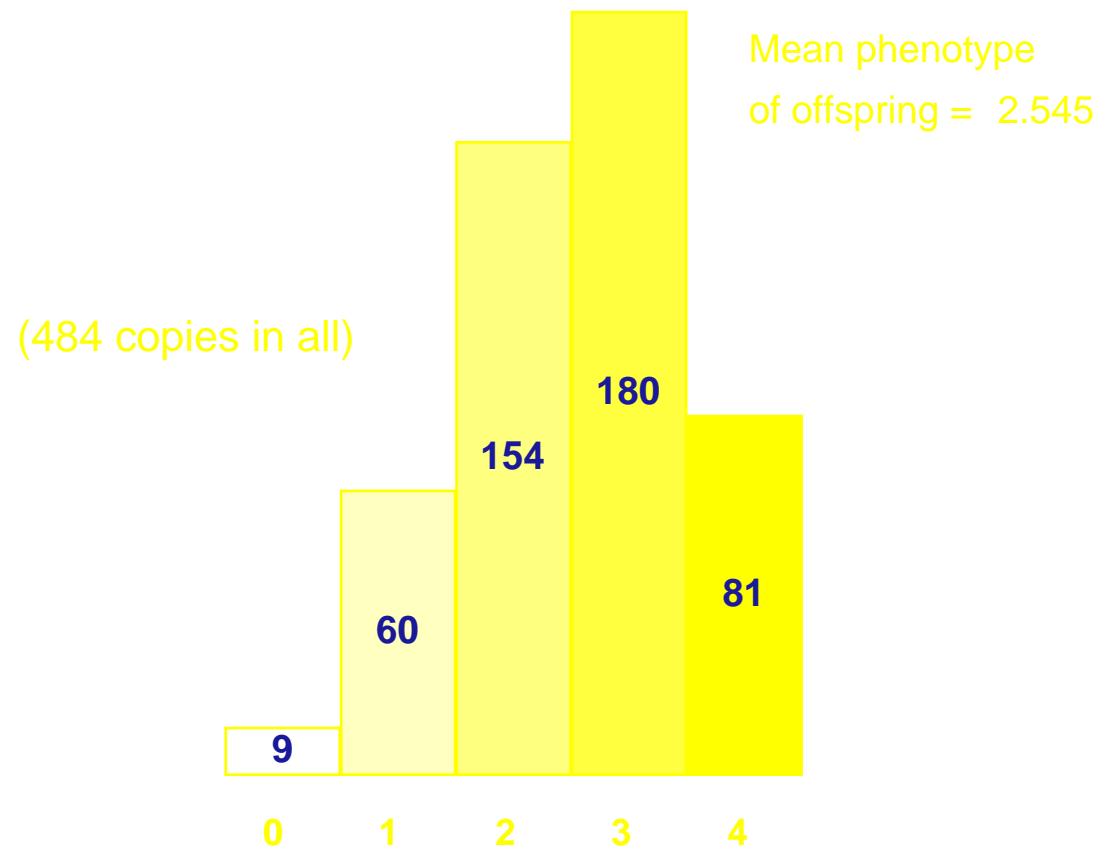
Characteristics of artificial selection

Some features of artificial selection experiments

a selection limit?

relaxation of selection

replicate lines

control line

reverse selection

mean phenotype

generations
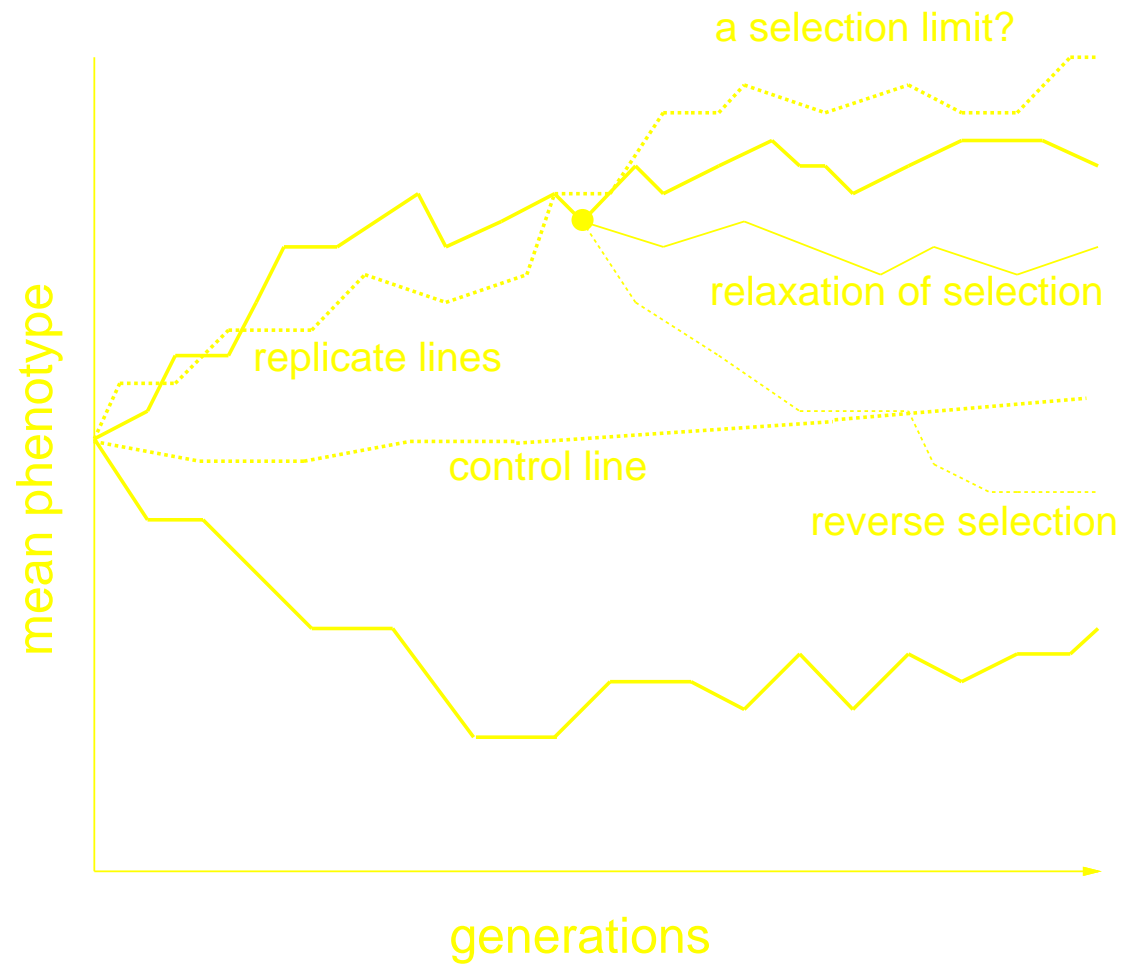
Tactics in selection experiments

- Directional selection

  – Selecting a trait in a particular direction over time

- Relaxed selection

  – Freely breeding a previous selected line with no further selection

- Reversed selection

  – Changing the direction of selection
  – If you've been selecting upwards, start selecting downwards

When artificial selection falters

- Recurrent selection for some trait can achieve remarkable deviations from "wild" conditions

- When the response to selection tapers off:

  - Genetic variability may be exhausted
  - Natural selection may be opposing your artificial selection
  - You may be selecting for two traits which are negatively correlated

Negatively correlated traits: example

- Select mice for total weight of all offspring

- Might have genetic variation in:
  - Number of offspring
  - Weight per offspring

- But if genotypes with more offspring always have lighter offspring, selection will stall

- This could be due to:
  - Genetic linkage (genes for number and size are linked)
  - Biological constraints (fitting in more offspring requires them to be smaller)

Practice problem

What will happen to a RELAXED line if:

- There is no more genetic variability?

- Natural selection is pushing the trait away from your original direction of selection?

- Your trait is really two traits which are interfering with each other?

Practice problem

What will happen to a REVERSED line if:

- There is no more genetic variability?

- Natural selection is pushing the trait away from your original direction of selection?

- Your trait is really two traits which are interfering with each other?

Why did the response to selection stop?

You can test this by relaxing or reversing selection

- Variability is exhausted

  – Neither relaxed nor reversed lines move

- Natural selection is opposing

  – Relaxed line tends to return to the original value
  – Reversed line may move past it

- Selection on negatively correlated traits

  – Relaxed line will tend to stay where it is
  – Reversed line may move for a while (if correlation isn't perfect) and then stall

Example: Long term selection experiment at University of Illinois on corn [start in 1896] (OIL)
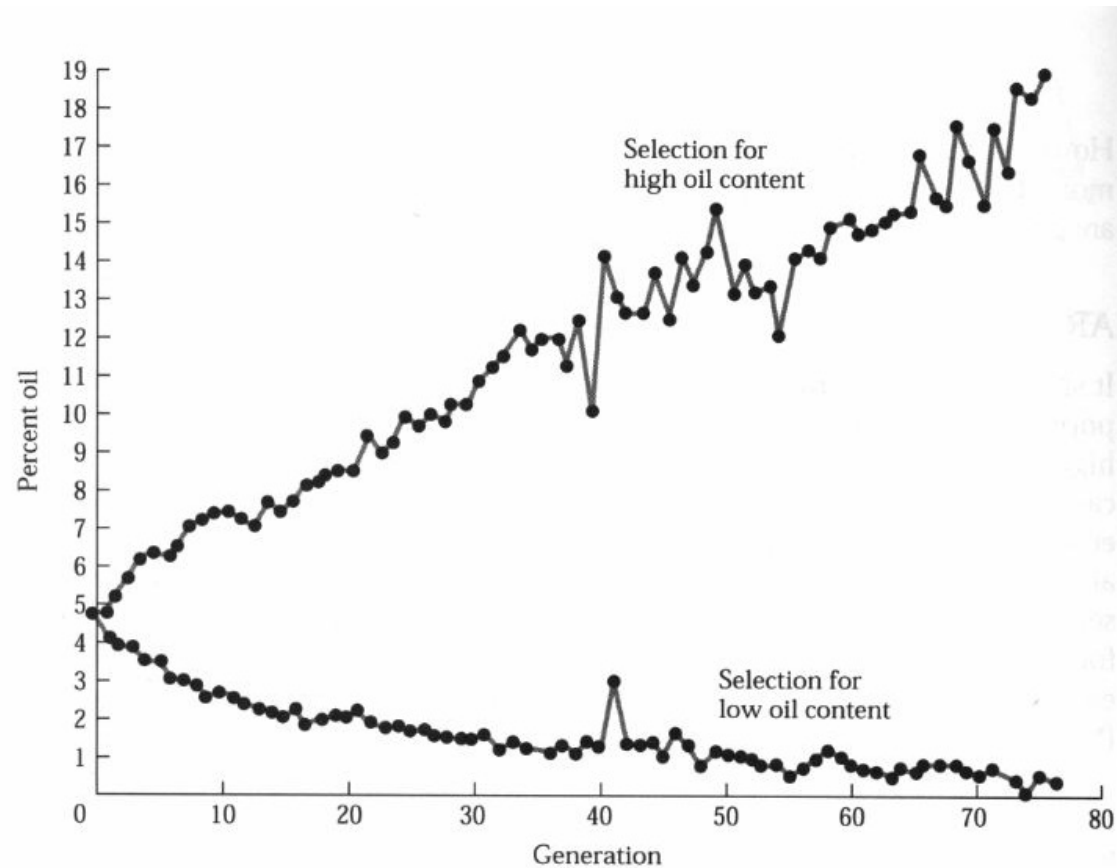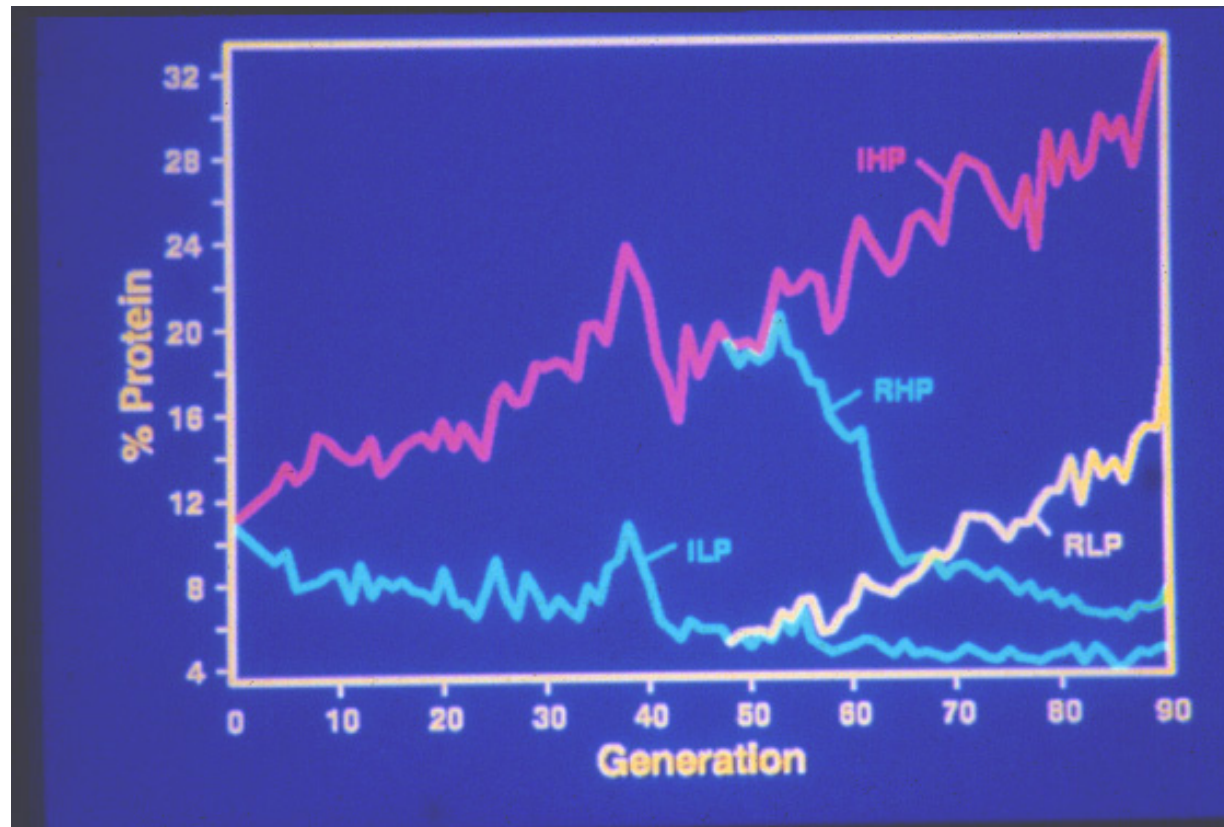

Figure 4.6 Results of a long-term experiment selecting for high and low oil content in corn seeds. Begun in 1896, the experiment has the longest duration of any on record and still continues at the University of Illinois. (After Dudley 1977.)
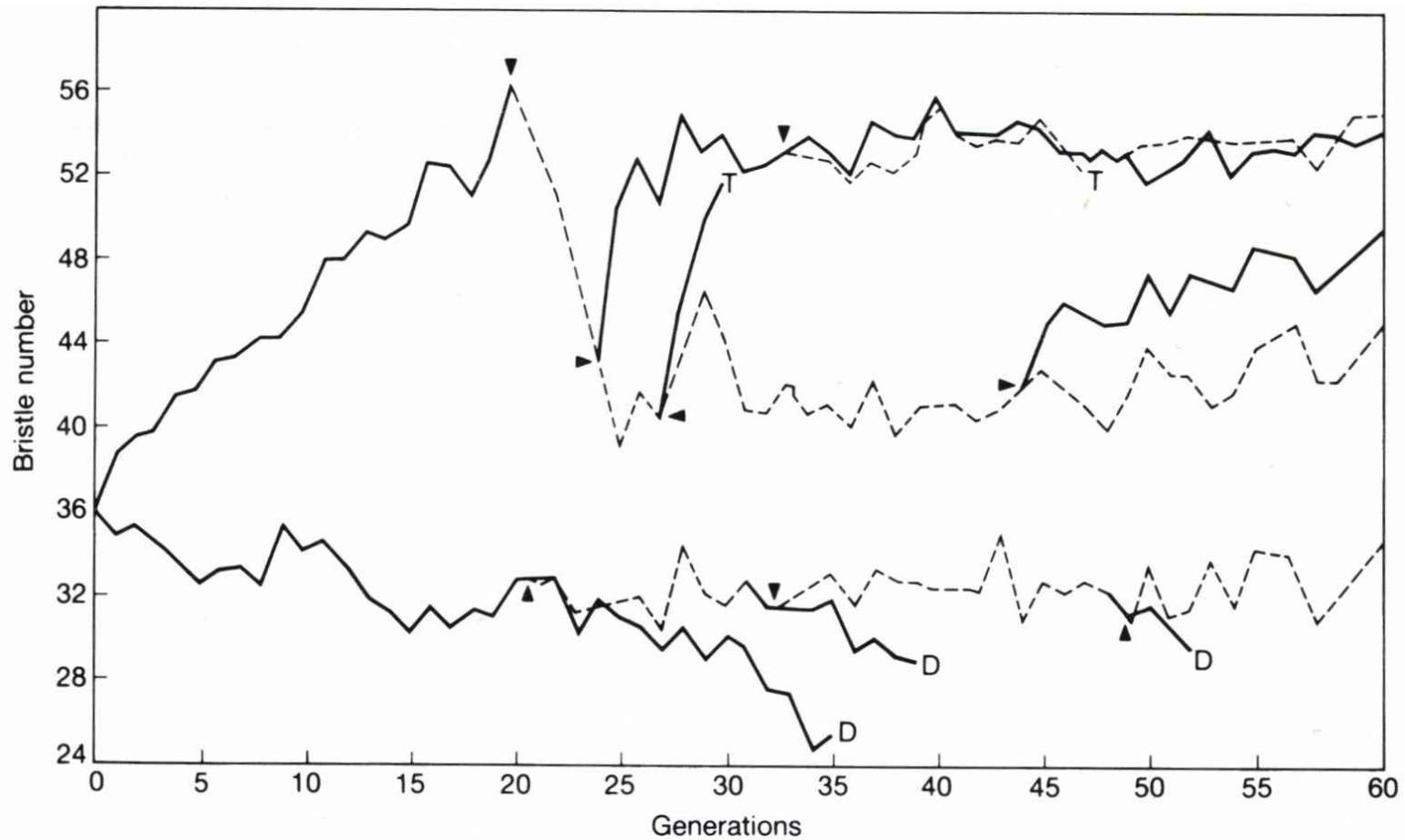
Example: Long term selection experiment at University of Illinois on corn (PROTEIN)

Example: Bristle number in Drosophila

Figure 6.11 Response to selection for abdominal bristle number in *Drosophila melanogaster* (after Mather and Harrison 1949). Full lines, selected populations; broken lines, populations in which selection was relaxed; T, line terminated deliberately; D, line died out through infertility.

What can artificial selection experiments tell us?

- How much genetic variability for a given trait does a population possess?

- What are the constraints on how far a trait can be pushed?

- Does selection on one trait affect another trait positively or negatively?

Correlation in pigs
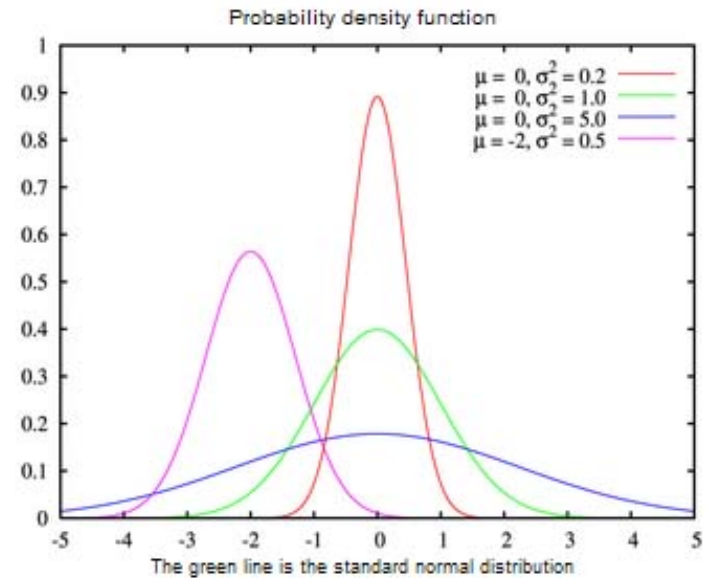
- Estany et al. 2002

- Pigs selected for increased litter size:

  - Grew more rapidly at young ages
  - Slowed growth more with increasing age
  - Ate less frequently
  - Spent more time eating per "meal"

- These findings may represent:

  - Genetic correlations among traits (linkage)
  - Biological correlations (constraints)
  - Genetic drift in small populations

Normal distribution

- Described by two parameters

  - Mean m (center point)
  - Standard deviation σ (spread)
  - Variance σ^2 (different measure of spread)

- Next lecture: using the normal distribution to model multi-gene traits

Probability density function

$\mu = 0, \sigma^2_2 = 0.2$
$\mu = 0, \sigma^2_2 = 1.0$
$\mu = 0, \sigma^2_2 = 5.0$
$\mu = -2, \sigma^2 = 0.5$

The green line is the standard normal distribution

One-minute responses

- Tear off a half-sheet of paper

- Write one line about the lecture:

  - Was anything unclear?
  - Did anything work particularly well?
  - What could be better?

- Leave at the back on your way out