IV. Genetic Variation in Natural Populations

A. Indirect evidence for genetic variation in populations

1. Observable polymorphism
2. Response to artificial selection
3. Effects of inbreeding

B. How much genetic variation is there?

C. More direct measurement of genetic variation

V. What maintains genetic variation in natural populations?

A. Genetic mechanisms

1. sexual reproduction
2. dominance
3. epistasis
4. linkage

B. Selection Mechanisms

1. heterozygote advantage
2. variation in selection

1. A survey of the peppered moth (Biston betularia) population of London gives the following result:

dark (melanic) morphs = 827
light morphs = 353

Given the M (melanic) is dominant to m (light), and assuming that the population is in Hardy-Weinberg equilibrium, answer the questions below:

(a) What is the frequency of the melanic allele in the population?

(b) What percentage of the moths will be melanic in the next generation?

(a). 827 + 353 = 1180

$q^2 = 353/1180 = 0.30$

q = sqr root (.30) = 0.55

p = 1 - q = **0.45**

(b) $p^2 + 2pq$ = frequency of melanic moths

$(0.45)^2 + 2\ (0.45)(0.55) =$ **0.70**

REVIEW FROM LAST TIME

Natural selection - differential survival and reproduction of phenotypes

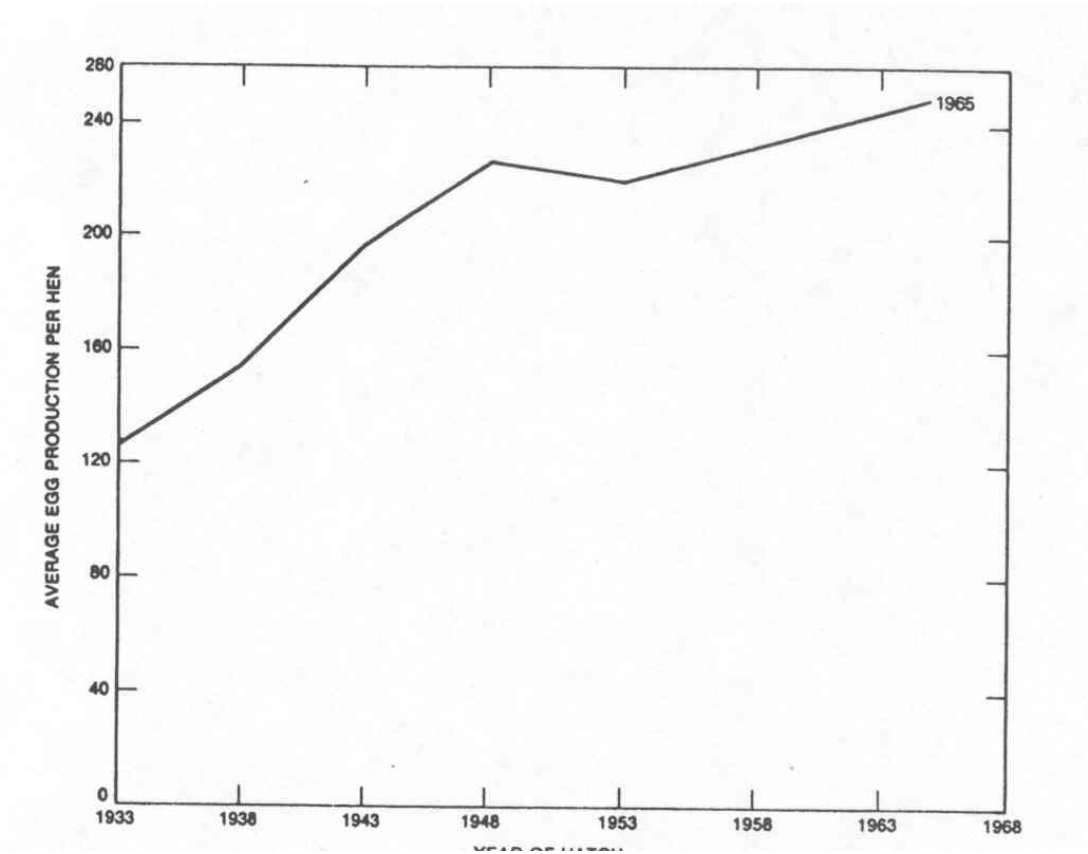
Adaptation - heritable modification of the phenotype that increases ability to survive and reproduce relative to those without the modification

Relative fitness - contribution of offspring to the next generation relative to others in the population

Better adapted phenotypes increase in frequency in a population due to natural selection because they have greater relative fitness

Directional selection on egg laying in domestic hens

Egg production



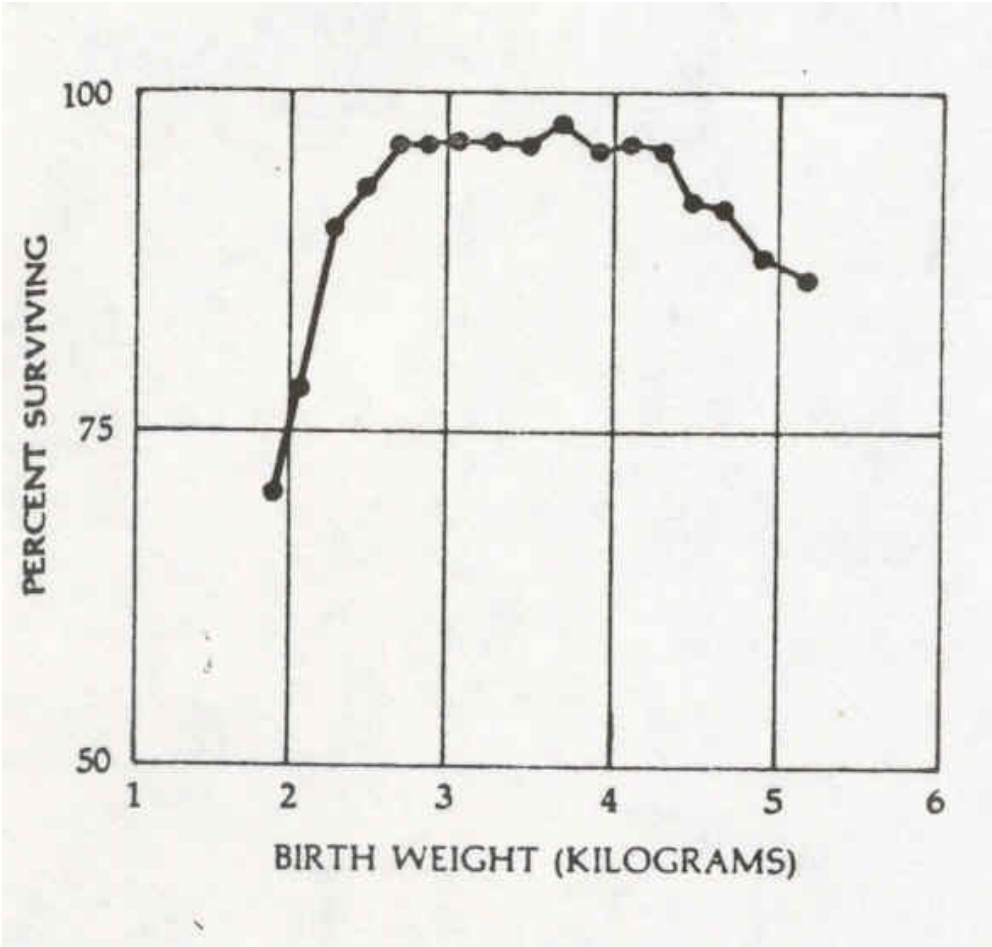
1933

125 eggs /yr

1968

245 eggs /yr

Stabilizing selection on human birth weight

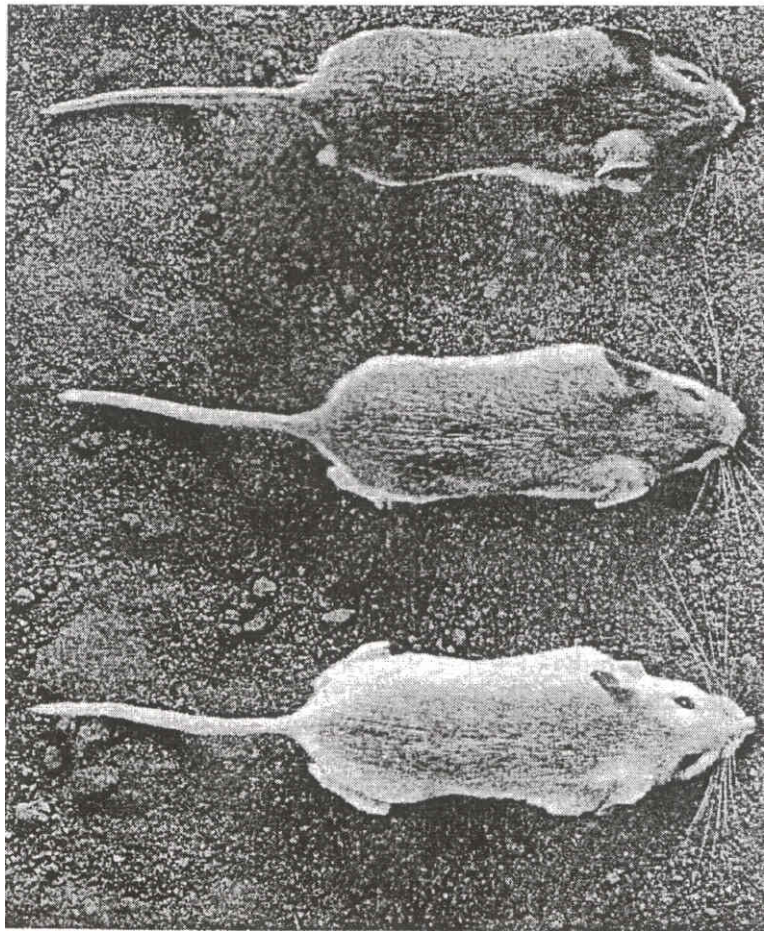


Stabilizing selection on number of eggs in starlings

Too many chicks?

Too few eggs?

Diversifying selection on coat color in deer mice



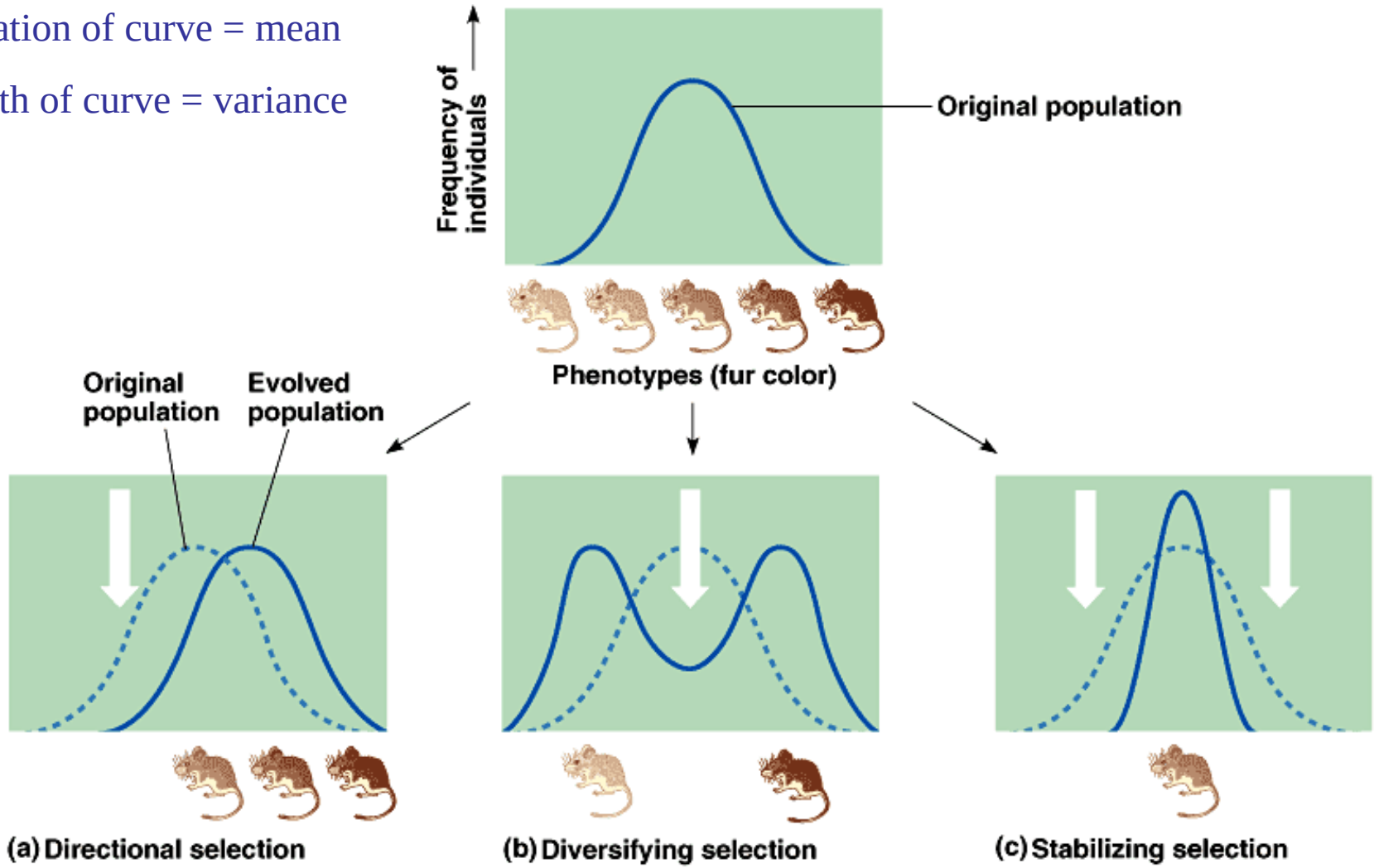
Dark color is favored on rich soil

Light color is favored on sandy soil

Fig. 23. 12 Effects of selection on phenotype distributions

Location of curve = mean

Width of curve = variance

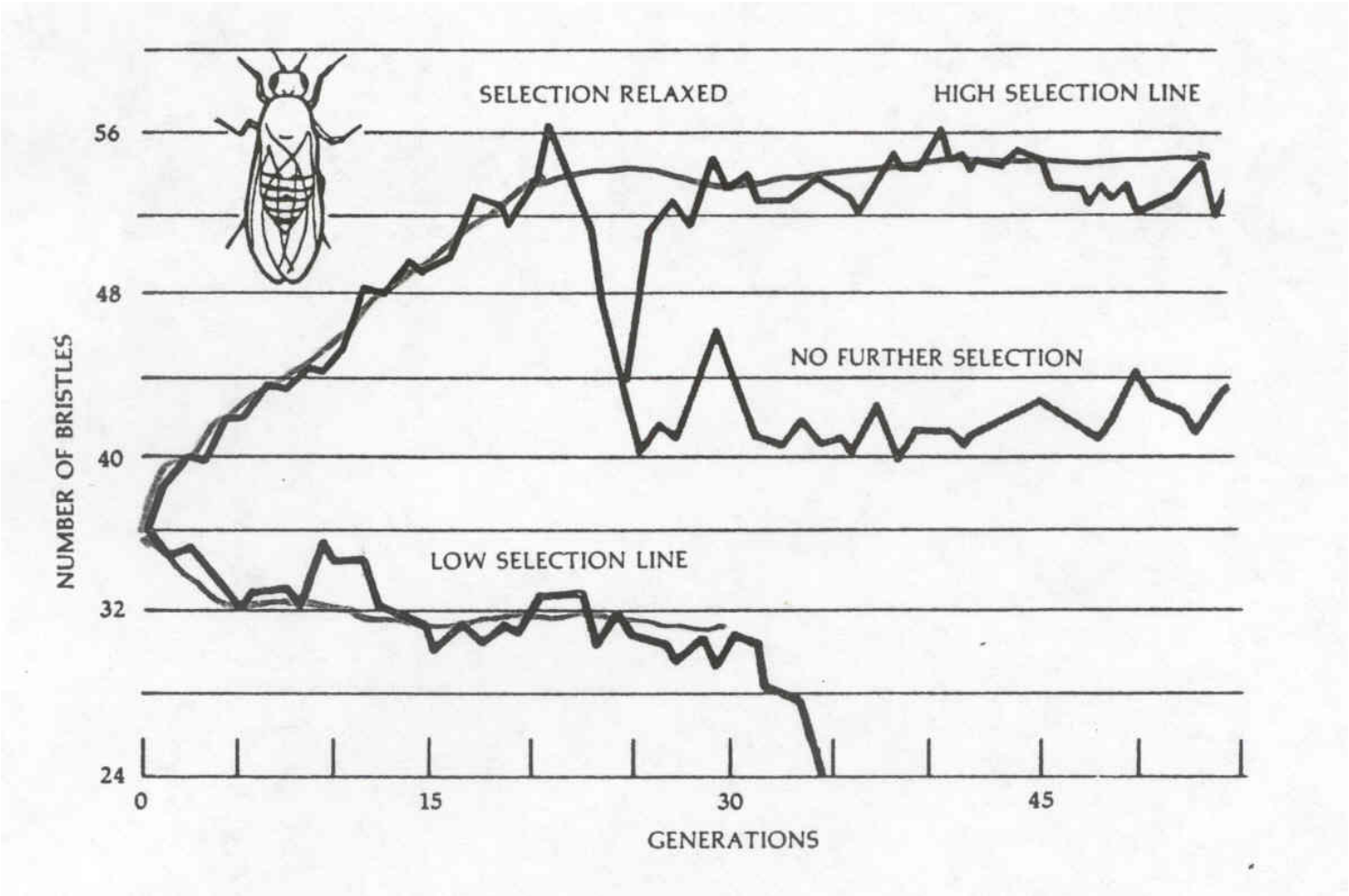


The Paradox of Variation:

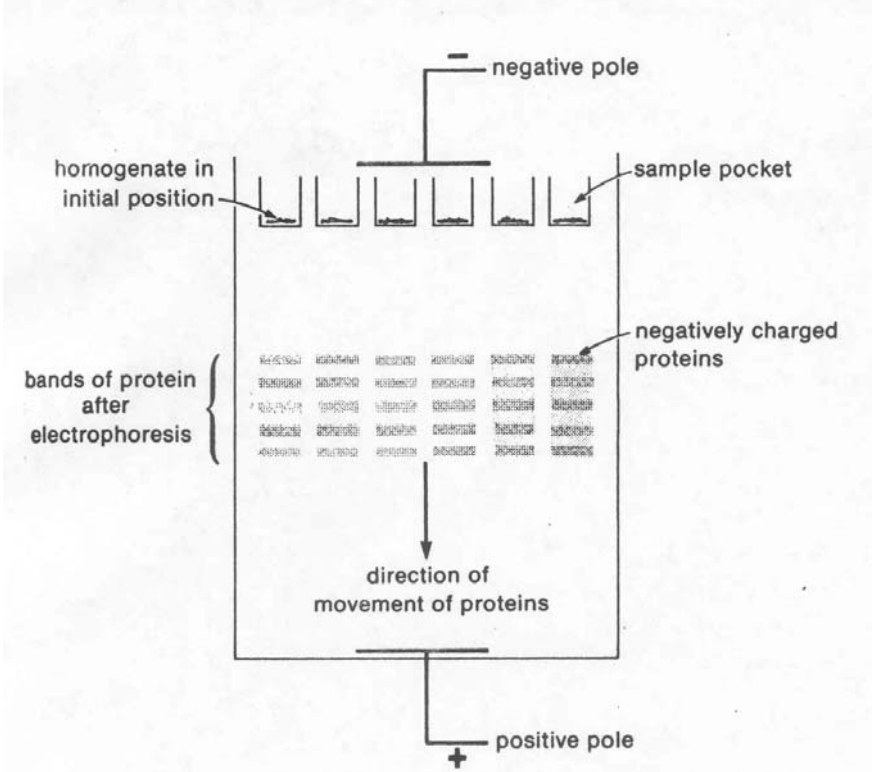
Evolution requires variation, but natural selection eliminates variation.

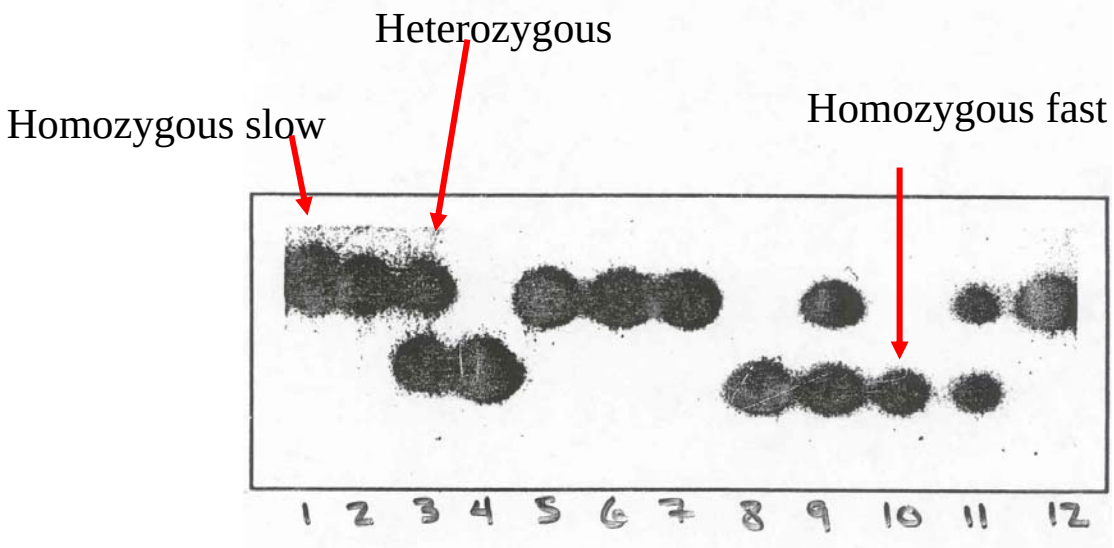
Visible polymorphism in the snow goose

Artificial selection on bristle number in Drosophila



Electrophoresis - separates proteins based on differences in size and electrical charge





Survey of electrophoretic variation in natural populations

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Organisms	Number of species studied	Average number of loci studied per species	Proportion of polymorphic loci per population*	Proportion of heterozygous loci per individual
Invertebrates				
Drosophila	28	24	0.529	0.150
Wasps	6	15	0.243	0.062
Other insects	4	18	0.531	0.151
Marine	14	23	0.439	0.124
Land snails	5	18	0.437	0.150
Vertebrates				
Fish	14	21	0.306	0.078
Amphibians	11	22	0.336	0.082
Reptiles	9	21	0.231	0.047
Birds	4	19	0.145	0.042
Mammals	30	28	0.206	0.051
Average values				
Invertebrates	57	21 .8	0.469	0.134
Vertebrates	68	24 .1	0.247	0.060
Plants	8	8	0.464	0.170

Fig 14.11 **Epistasis** can hide dominant alleles from natural selection

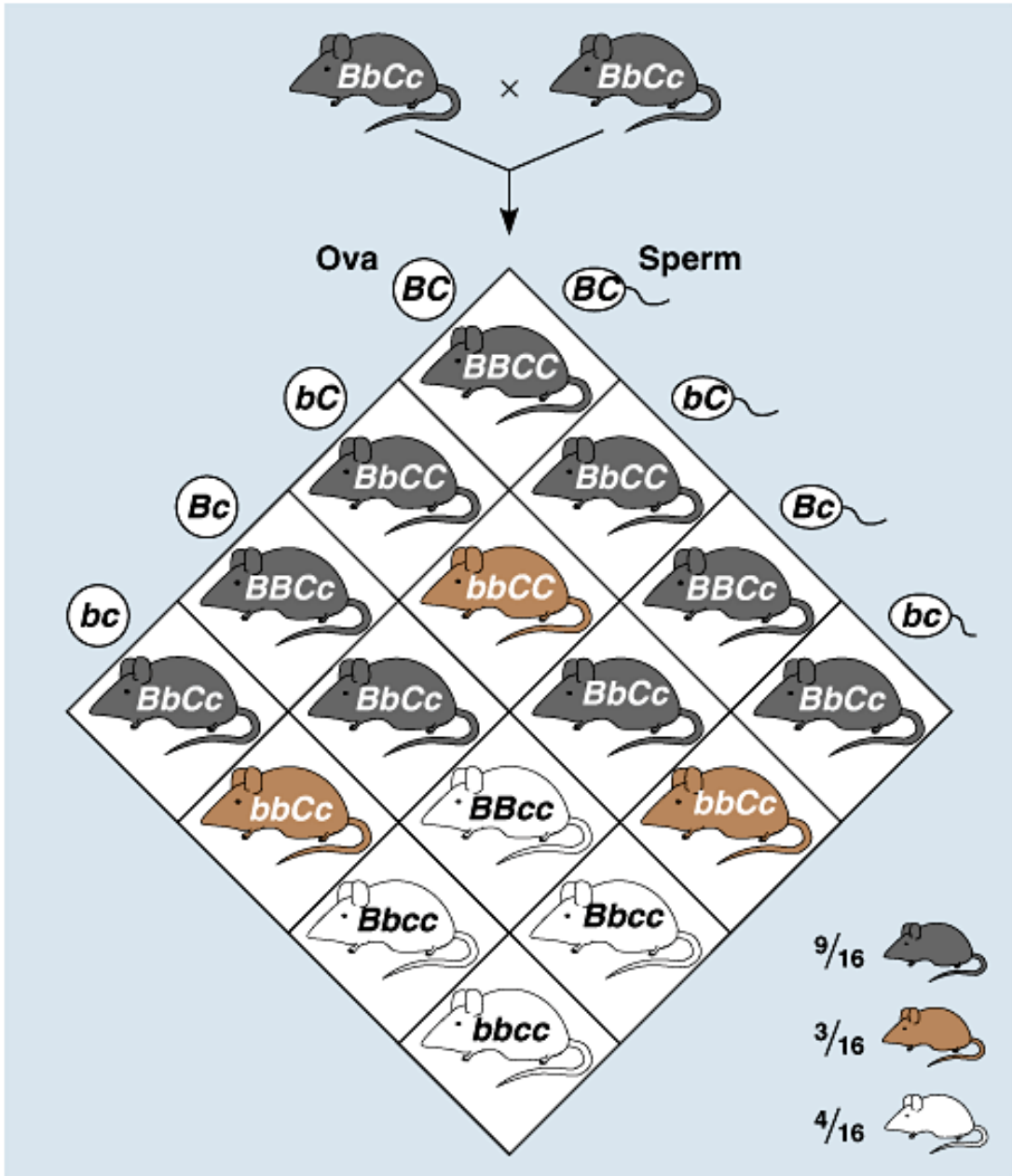
C= pigment

c = none

B = deposition of lots of pigment (black)

b = less deposition (brown)

If cc, fur is white regardless of genotype at B locus

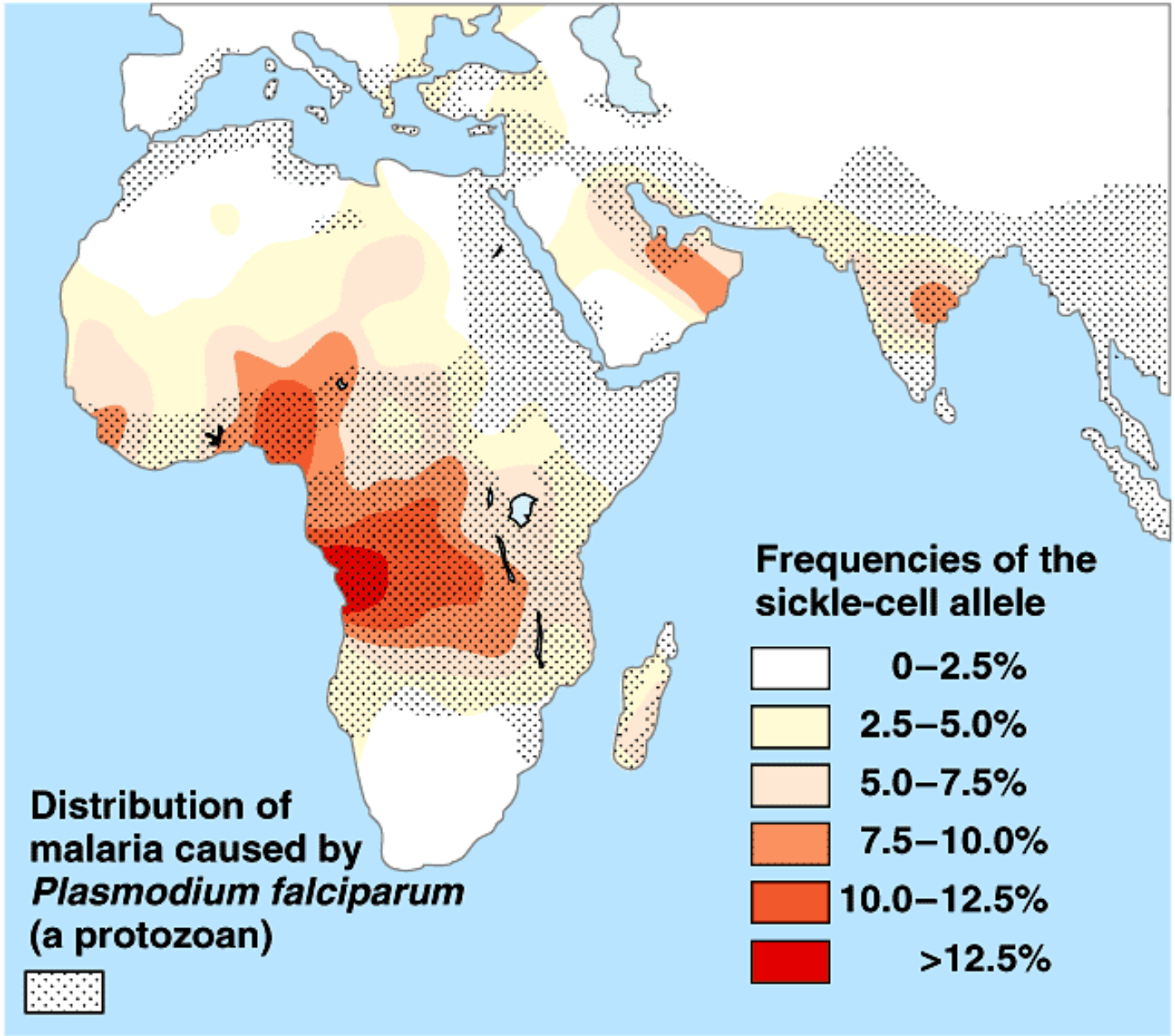


Heterozygote advantage in Sickle cell anemia:

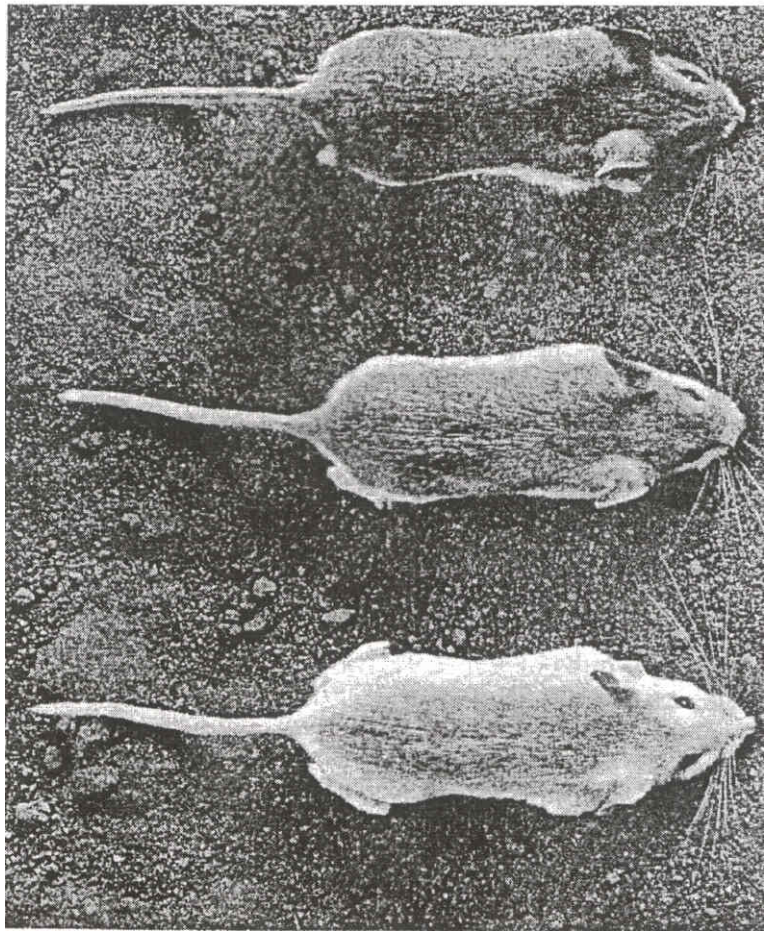
Hb+ = normal RBC

(co-dominant) Hbs = sickled RBC

Genotype	RBC	Susceptibility to malaria	Relative fitness
HB+ Hb+	normal	highest	intermediate
Hb+ Hbs	normal*	lower	highest
Hbs Hbs	sickled	lower	lowest



Diversifying selection on coat color in deer mice

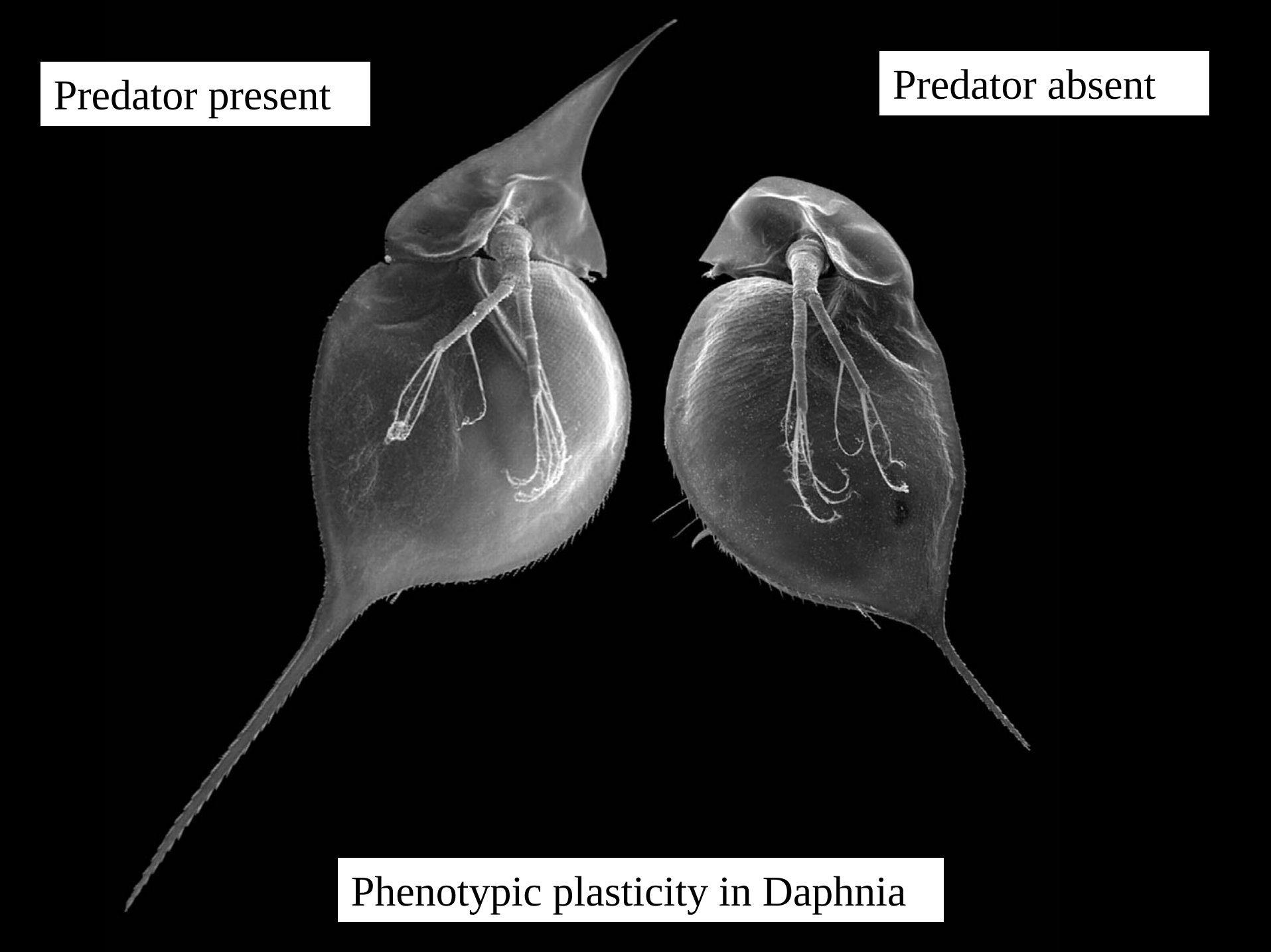


Dark color is favored on rich soil

Light color is favored on sandy soil

Diversifying selection in time in the snow goose

Nesting habitat


Predator present
Predator absent
Phenotypic plasticity in Daphnia