4-cr abstract by Friday, Oct. 9
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Lecture Handout 9

-The **level of dominance, h**, when multiplied by **s** measures the amount of selection against the heterozygote.

Allows for multiple levels of dominance.

Specific fitness relationships

If h = 0, fitness array matches detrimental recessive model;
If h = 0.5 matches additive model

TABLE 3.5 The fitness values for the different fitness relationships examined.

	Genotype		
	A_1A_1	A_1A_2	A_2A_2
General fitnesses	w_{11}	w_{12}	w_{22}
(a) Recessive lethal	1	1	0
(b) Detrimental alleles			
(1) Recessive	1	1	$1-s$
(2) Additive	1	$1-s/2$	$1-s$
(3) Dominant	1	$1-s$	$1-s$
(c) General dominance			
(1) Purifying selection	1	$1-hs$	$1-s$
(2) Adaptive Darwinian selection	$1+s$	$1+hs$	1
(d) Heterozygote advantage	$1-s_1$	1	$1-s_2$
(e) Heterozygote disadvantage	$1+s_1$	1	$1+s_2$

Purifying selection: selection that reduces the frequency of deleterious alleles in a population. On Table 3.5, examples (a), (b), and (c)(1). Fitness **disadvantage** for ***s***.

Adaptive or positive Darwinian selection: selection for alleles that are advantageous in the present environment. Table 3.5 (c)(2): fitness **advantage** for ***s.***

Specific fitness relationships

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Purifying selection

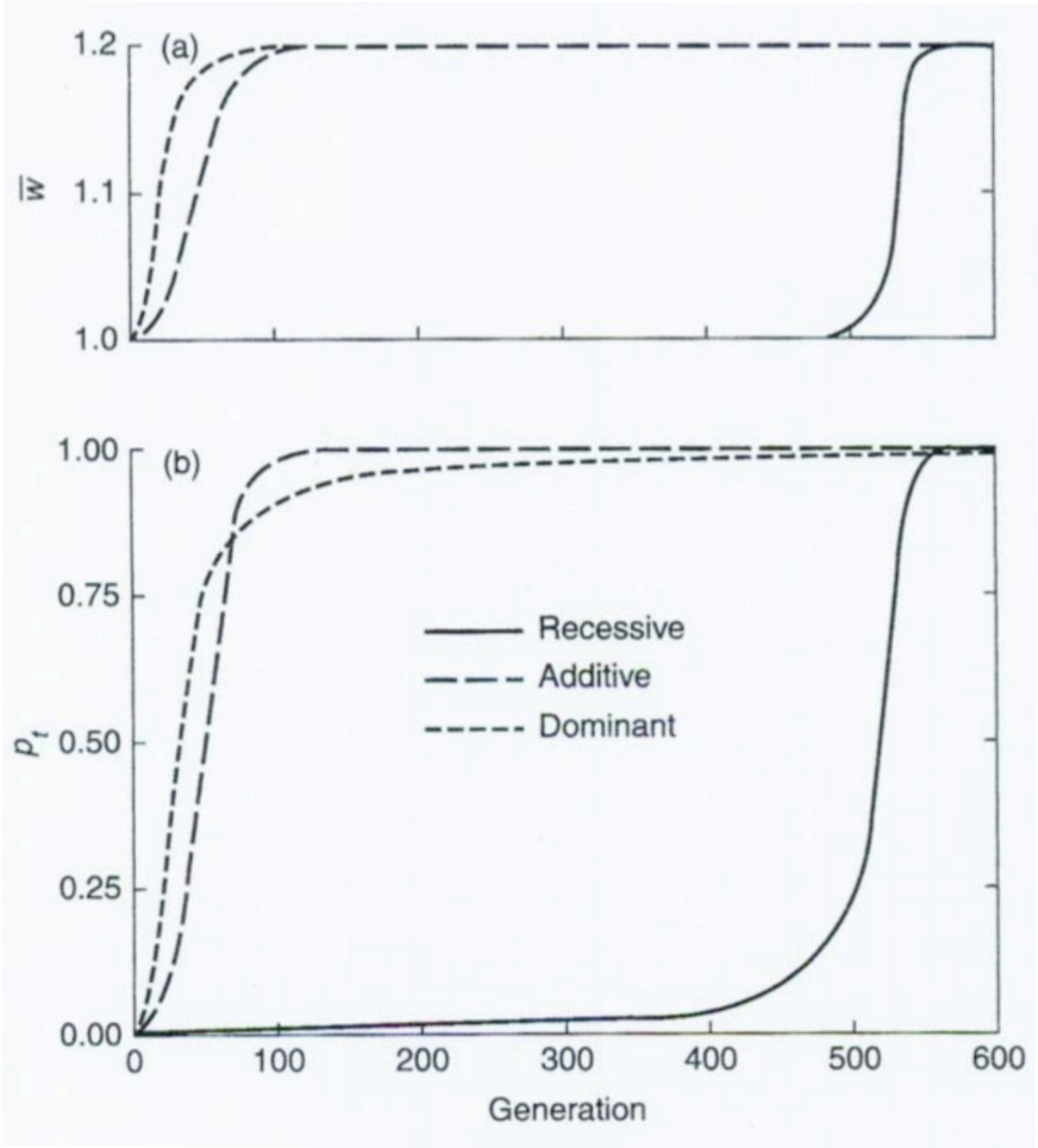
Adaptive or **positive** Darwinian selection

Note differences when h=0

Purifying selection: focus is on reduction in frequency of detrimental allele A_2.

Adaptive or positive Darwinian selection: focus is on increase in frequency of beneficial allele A_1 (introduced at some low level by mutation or gene flow).

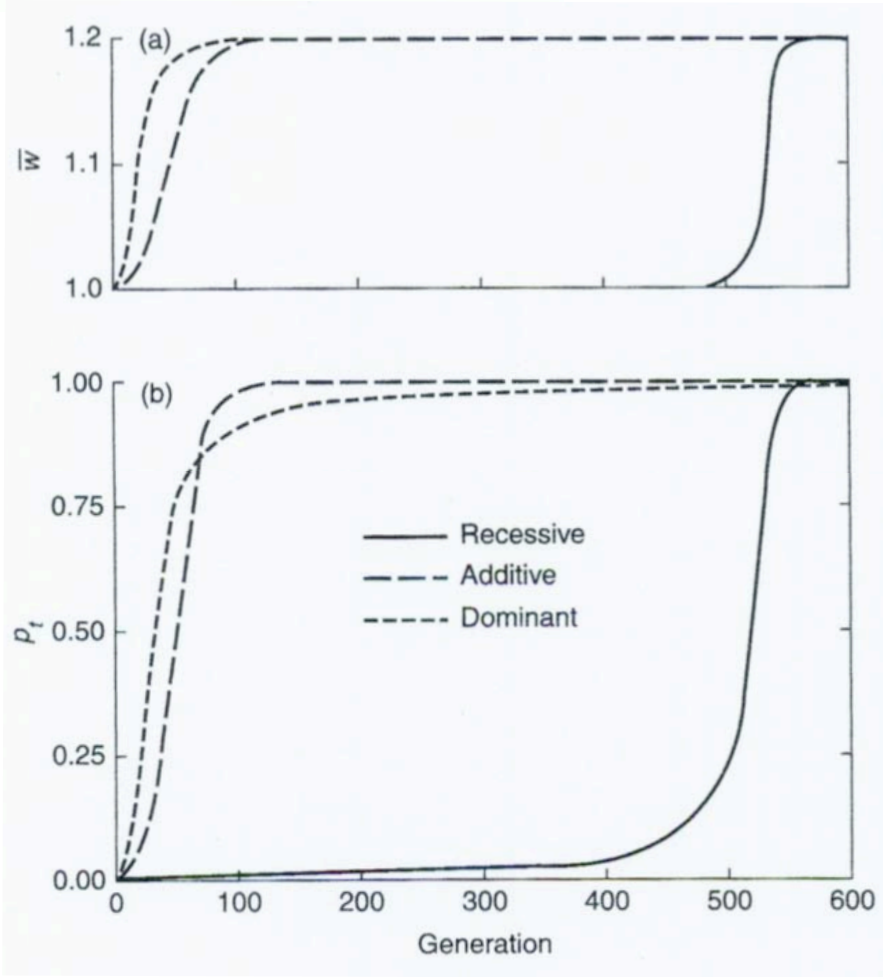
Where selection favors an allele, frequencies of the favored allele will rise more quickly for favored dominant (and additive) alleles than for favored recessive alleles
Fig 3.5,
p(init) = 0.01
s = 0.1



$$\Delta q = -\frac{spq[h + p(1 - 2h)]}{1 + 2hspq + sp^2}$$

Rise of allele $\mathbf{A_1}$ under positive Darwinian selection depends on its:

-dominance (h)
-selection coefficient (s)
-frequency (**p**)



Classic case of Darwinian selection:

peppered moth, *Biston betularia*

white form

black form

Industrial melanism: use of coal in 19th century led to darkening of tree bark by soot and loss of lichen giving black moths better camouflage from birds

white form

black form

Industrial melanism: frequency of black moth form in many areas of Britain reached 100% by the mid-20th century. Yet in 1956, Britain passed laws against air pollution…

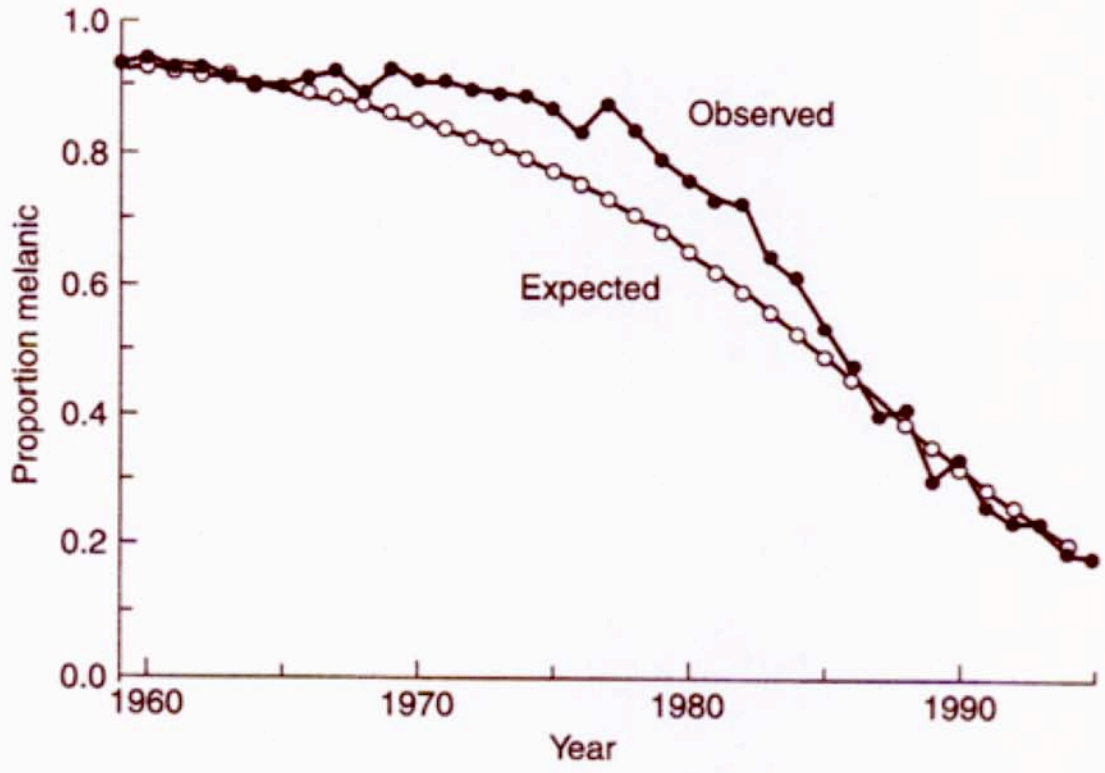


Figure 3.6. The observed decline in the frequency of melanics over 26 years at Caldy Common in England (closed circles). The open circles give the predicted decline when $s = 0.153$ against the melanics (after Grant *et al.*, 1996).

Heterozygous advantage or overdominance

TABLE 3.5 The fitness values for the different fitness relationships examined.

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s_1 and s_2 are the selective disadvantage for A_1A_1 and A_2A_2 respectively

Overdominance or Heterozygote advantage over either homozygote

Allele frequency after selection:

$$q_1 = \frac{q_0 - s_2 q_0^2}{1 - s_1 p_0^2 - s_2 q_0^2}$$

Change in the frequency of A_2:

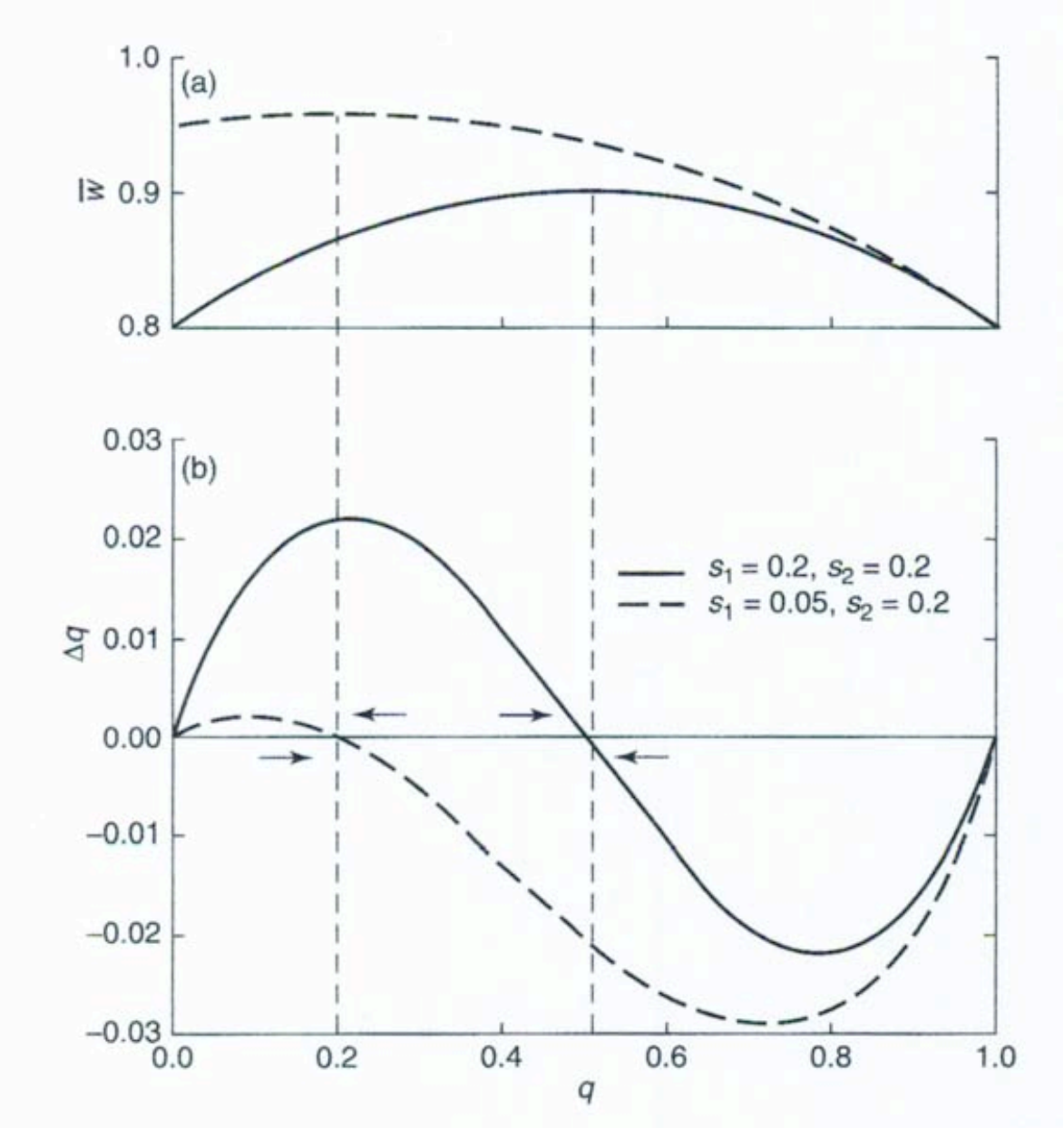
$$\Delta q = \frac{pq(s_1 p - s_2 q)}{1 - s_1 p^2 - s_2 q^2}$$

Overdominance or Heterozygote advantage over either homozygote. Equilibrium (stable frequencies of alleles across generations) occurs for allele A_2 when :

$$q_e = \frac{s_1}{s_1 + s_2}$$

This is known as the **equilibrium frequency of allele A_2**

Overdominance or Heterozygote advantage



Overdominance or Heterozygote advantage over either homozygote.

Mean fitness (ω_e) at the equilibrium allele frequencies:

$$= 1 - \frac{s_1 s_2}{s_1 + s_2}$$

genetic load: the reduction in fitness from the maximum possible in a population. (Due primarily to balanced recessive detrimental alleles in a selection-mutation balance, and to segregation of homozygotes when there is a heterozygous advantage.)

Heterozygous disadvantage or underdominance

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s_1 and s_2 are the selective **advantage** for A_1A_1 and A_2A_2 respectively

Heterozygous disadvantage or underdominance

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