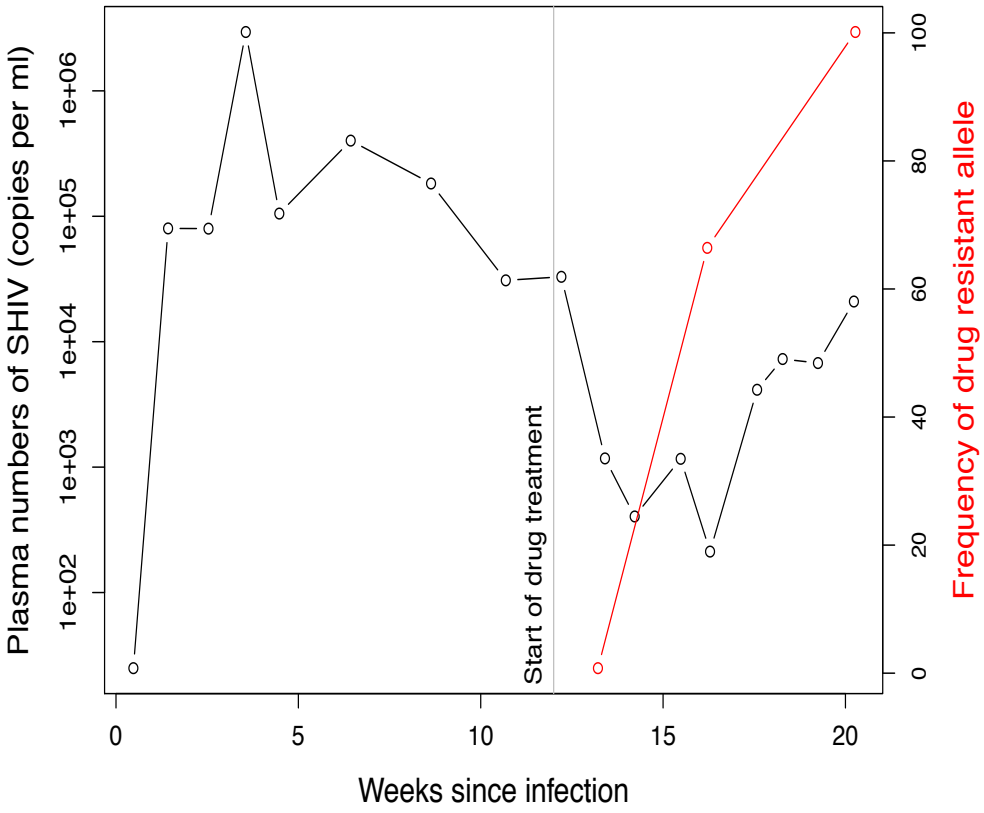
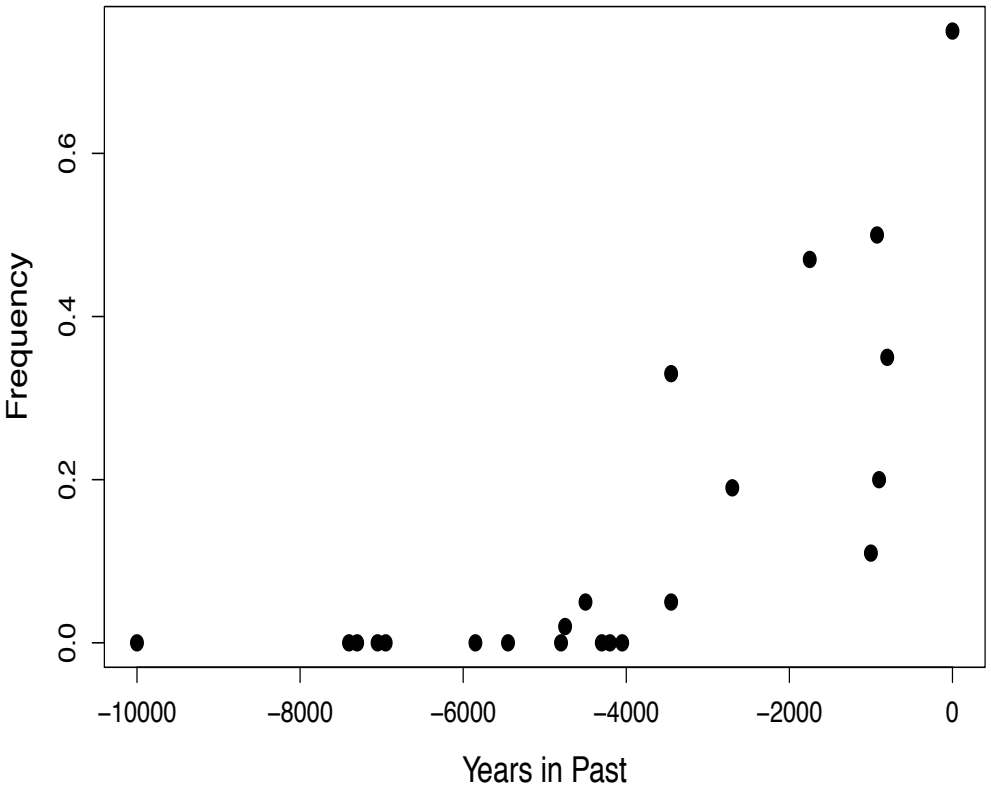

Plasma numbers of SHIV (copies per ml)
1e+02
1e+03
1e+04
1e+05
1e+06
Start of drug treatment
Frequency of drug resistant allele
0
20
40
60
80
100
0
5
10
15
20
Weeks since infection


Frequency
0.0
0.2
0.4
0.6
−10000
−8000
−6000
−4000
−2000
0
Years in Past

Haploid model of selection

Consider alleles A_1 and A_2 at frequency p_t and $q_t = 1 - p_t$ at time t, and assume that the population size N is so large that we can ignore genetic drift.

Diploid model of selection

Consider alleles A_1 and A_2 at frequency p_t and $q_t = 1 - p_t$ at time t, and assume that the population size N is so large that we can ignore genetic drift.

Genotype	A_1A_1	A_1A_2	A_2A_2
Absolute fitness	W_{11}	W_{12}	W_{22}

Change in allele frequencies due to viability selection

$$p_{t+1} = f_{11} + \frac{1}{2} f_{12} = \frac{w_{11} p_t + w_{12} q_t}{\bar{w}} p_t$$

$$\Delta p_t = p_{t+1} - p = \frac{w_{11} p_t + w_{12} q_t}{\bar{w}} p_t - p_t$$

$$\bar{w}_1 = w_{11} p_t + w_{12} q_t$$

$$\bar{w}_2 = w_{12} p_t + w_{22} q_t$$

Marginal fitnesses of A_i: weighted mean fitness across genotypes carrying A_i

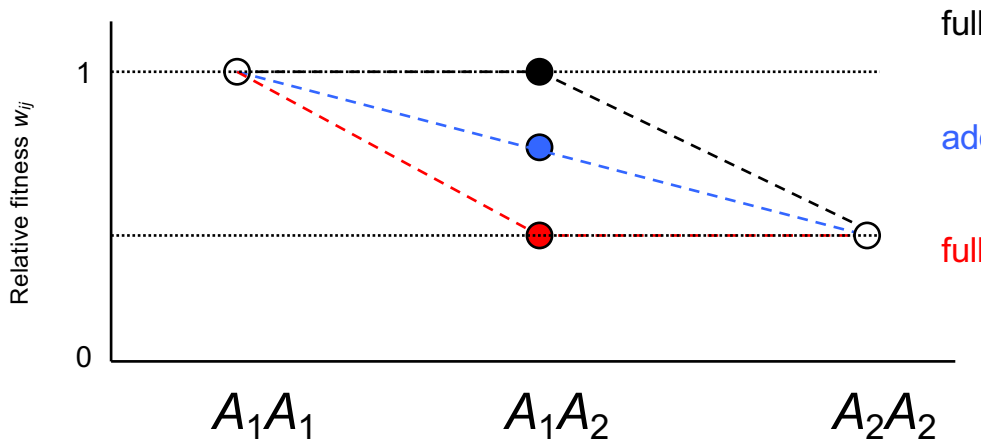
$$\Delta p_t = \frac{\bar{w}_1 - \bar{w}_2}{\bar{w}} p_t q_t, \qquad \Delta q_t = -\Delta p_t$$

Frequency of A_1 is expected to increase if the marginal fitness of A_1 is higher than A_2, regardless of how small the difference

$$\Delta p_t = \frac{1}{2} p_t q_t \frac{d\bar{w}}{dp_t}$$

Alternative formulation by Haldane (1924). Frequency of A_1 increases if mean fitness is an increasing function of frequency of A_1.

Directional selection



fully recessive $h = 0$

additive $h = 0.5$

fully dominant $h = 1$

w_{ij}	A_1A_1	A_1A_2	A_2A_2
	1	$1 - hs$	$1 - s$

$$\overline{w}_1 = w_{11}p_t + w_{12}q_t = p_t + (1 - hs)q_t$$

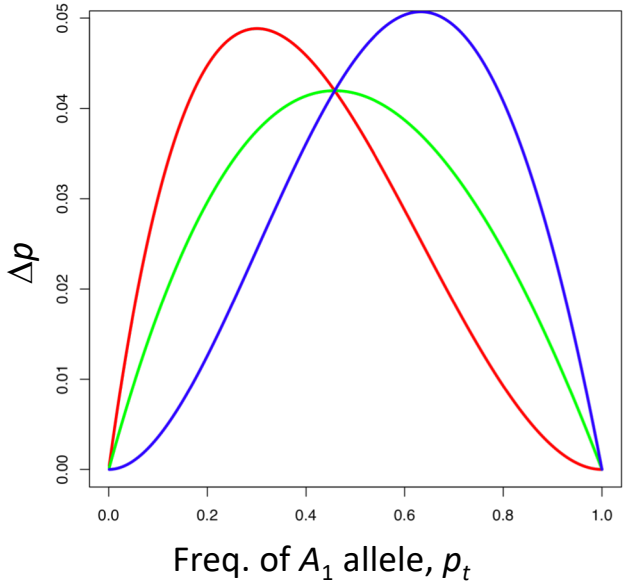
$$\overline{w}_2 = w_{12}p_t + w_{22}q_t = (1 - hs)p_t + (1 - s)q_t$$

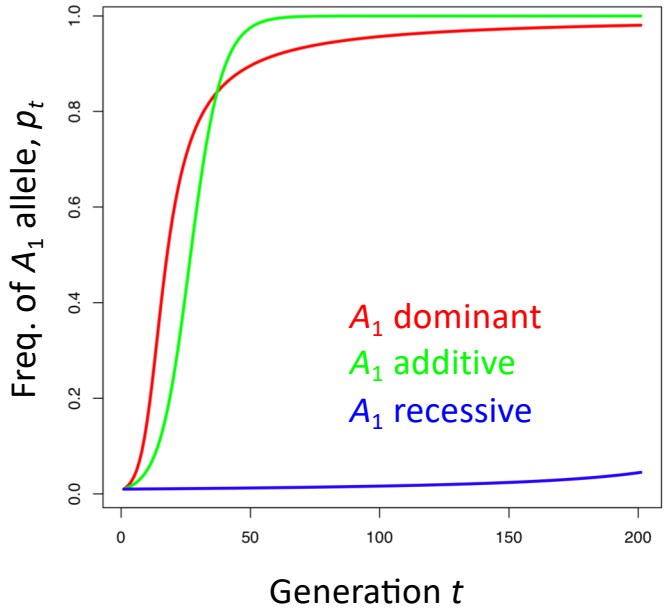
$$\Delta p_t = \frac{\overline{w}_1 - \overline{w}_2}{\overline{w}} p_t q_t = \frac{p_t hs + q_t s(1 - h)}{\overline{w}} p_t \overset{\substack{h=1/2 \\ s<<1}}{\approx} \frac{1}{2} s p_t q_t$$

$$\overline{w}_1 = w_{11}p_t + w_{12}q_t = p_t + (1 - hs)q_t$$

$$\overline{w}_2 = w_{12}p_t + w_{22}q_t = (1 - hs)p_t + (1 - s)q_t$$

$$\Delta q_t = \frac{\overline{w}_2 - \overline{w}_1}{\overline{w}} p_t q_t = \frac{-p_t hs - q_t s(1-h)}{\overline{w}} q_t$$

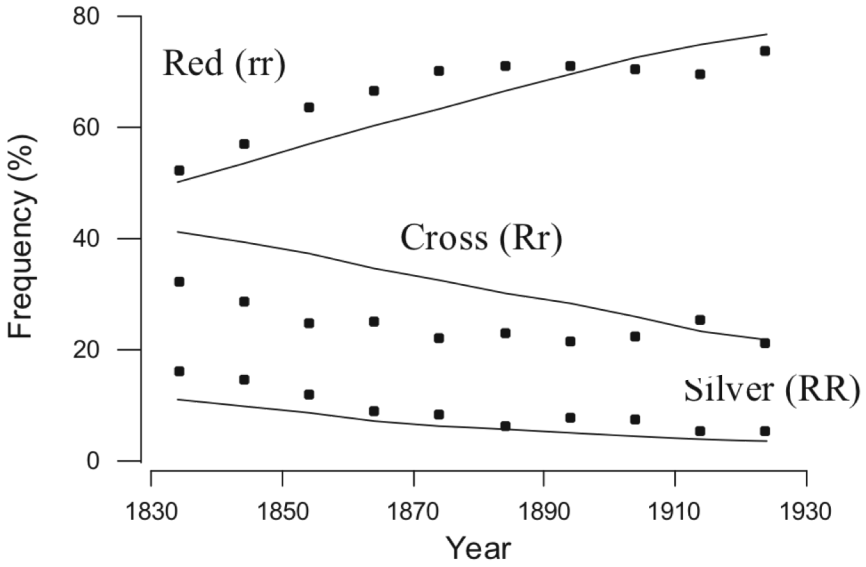




Beneficial dominant alleles are quick to spread but slow to fix.

Red Morph:
Homozygotes rr and heterozygotes rR

Silver fox morph :RR homozygote



Silver fox pelts were particularly valuable to hunters

Rates of Evolution: Effects of Time and Temporal Scaling

Abstract. *Rates of morphological evolution documented in laboratory selection experiments, historical colonization events, and the fossil record are inversely related to the interval of time over which they are measured. This inverse relation-*

Gingerich (Science 1983)

Estimates of rate made over longer time intervals are slower than those measured over shorter time intervals