Genetics of Natural Selection

Symbols used

Symbol	Definition
N	number of individuals in the population
u	frequency of ST/ST genotype
v	frequency of ST/CH genotype
w	frequency of CH/CH genotype
w_{11}	fitness of ST/ST genotype
w_{12}	fitness of ST/CH genotype
w_{22}	fitness of CH/CH genotype

Calculation

Genotype	ST/ST	ST/CH	CH/CH
Number in eggs	41	82	27
	uN	vN	wN
Viability	0.6	0.9	0.45
	w_{11}	w_{12}	w_{22}
Number in adults	25	74	12
	$w_{11}uN$	$w_{12}vN$	$w_{22}wN$

Genotype frequencies

$$\begin{aligned}\text{freq(ST/ST) before selection} &= \frac{41}{41+82+27} \\ &= \frac{uN}{uN+vN+wN} \\ &= 0.27 \\ &\quad u\end{aligned}$$

$$\begin{aligned}\text{freq(ST/ST) after selection} &= \frac{25}{25+74+12} \\ &= \frac{w_{11}uN}{w_{11}uN+w_{12}vN+w_{22}wN} \\ &= 0.23\end{aligned}$$

$$\frac{w_{11}u}{w_{11}u + w_{12}v + w_{22}w}$$

$\bar{w} = w_{11}u + w_{12}v + w_{22}w$ is the mean fitness

Allele frequencies

$$\begin{aligned}
\text{freq(ST) before selection} &= \frac{2(41) + 82}{2(41 + 82 + 27)} \\
&\quad \frac{2(uN) + vN}{2(uN + vN + wN)} \\
&= 0.55 \\
&\quad u + \frac{v}{2}
\end{aligned}$$

$$\begin{aligned}
\text{freqST after selection} &= \frac{2(25) + 74}{2(25 + 74 + 12)} \\
&\quad \frac{2w_{11}uN + w_{12}vN}{2({}_{11}uN + w_{12}vN + w_{22}wN)} \\
&= 0.56 \\
&\quad \frac{2w_{11}u + w_{12}v}{2({}_{11}u + w_{12}v + w_{22}w)}
\end{aligned}$$

$$\begin{aligned}
p' &= \frac{w_{11}u + w_{12}v/2}{w_{11}u + w_{12}v + w_{22}w} \\
&\quad \text{Assume H-W from adults to zygotes} \\
u &= p^2 \\
v &= 2pq \\
w &= q^2 \\
p' &= \frac{w_{11}p^2 + w_{12}pq}{w_{11}p^2 + w_{12}2pq + w_{22}q^2}
\end{aligned}$$

Fisher's Fundamental Theorem of Natural Selection

$$\bar{w}' \geq \bar{w}$$

Natural selection causes allele frequencies to change in such a way that the mean fitness of the progeny generation ($\bar{w}'$) is greater than that of the parental generation ($\bar{w}$).