

Expected frequency of altruists in the population

$$\mathbb{E}[\bar{X}] = \nu + \delta \nu(1 - \nu) \frac{1 - \mu}{\mu} (1 - Q_{\text{out}}) \times$$

$$\left(-c - (b - c) \left(\frac{(1 - m)^2}{n} + \frac{m^2}{n(N_d - 1)} \right) \right.$$

$$\left. + \frac{Q_{\text{in}} - Q_{\text{out}}}{1 - Q_{\text{out}}} \left[b - (b - c)(n - 1) \left(\frac{(1 - m)^2}{n} + \frac{m^2}{n(N_d - 1)} \right) \right] \right)$$

Expected frequency of altruists in the population

Mutation-drift
equilibrium

$$\mathbb{E}[\bar{X}] = \nu + \delta \nu(1 - \nu) \frac{1 - \mu}{\mu} (1 - Q_{\text{out}}) \times$$
$$\left(-c - (b - c) \left(\frac{(1 - m)^2}{n} + \frac{m^2}{n(N_d - 1)} \right) \right.$$
$$\left. + \frac{Q_{\text{in}} - Q_{\text{out}}}{1 - Q_{\text{out}}} \left[b - (b - c)(n - 1) \left(\frac{(1 - m)^2}{n} + \frac{m^2}{n(N_d - 1)} \right) \right] \right)$$

Expected frequency of altruists in the population

Mutation-drift
equilibrium Selection
strength

$$\mathbb{E}[\bar{X}] = \underbrace{\nu}_{\text{Mutation-drift equilibrium}} + \underbrace{\delta}_{\text{Selection strength}} \nu(1-\nu) \frac{1-\mu}{\mu} (1-Q_{\text{out}}) \times$$

$$\left(-c - (b-c) \left(\frac{(1-m)^2}{n} + \frac{m^2}{n(N_d-1)} \right) \right.$$

$$\left. + \frac{Q_{\text{in}} - Q_{\text{out}}}{1 - Q_{\text{out}}} \left[b - (b-c)(n-1) \left(\frac{(1-m)^2}{n} + \frac{m^2}{n(N_d-1)} \right) \right] \right)$$

Expected frequency of altruists in the population

Mutation-drift equilibrium
 Selection strength
 Variance in the state of one site

$$\begin{aligned}
 \mathbb{E}[\bar{X}] = & \underbrace{\nu}_{\text{Mutation-drift equilibrium}} + \underbrace{\delta}_{\text{Selection strength}} \underbrace{\nu(1-\nu)}_{\text{Variance in the state of one site}} \frac{1-\mu}{\mu} (1-Q_{\text{out}}) \times \\
 & \left(-c - (b-c) \left(\frac{(1-m)^2}{n} + \frac{m^2}{n(N_d-1)} \right) \right. \\
 & \left. + \frac{Q_{\text{in}} - Q_{\text{out}}}{1 - Q_{\text{out}}} \left[b - (b-c)(n-1) \left(\frac{(1-m)^2}{n} + \frac{m^2}{n(N_d-1)} \right) \right] \right)
 \end{aligned}$$

Expected frequency of altruists in the population

Mutation-drift equilibrium Selection strength Variance in the state of one site

$$\mathbb{E}[\bar{X}] = \underbrace{\nu}_{\text{Mutation-drift equilibrium}} + \underbrace{\delta}_{\text{Selection strength}} \underbrace{\nu(1-\nu)}_{\text{Variance in the state of one site}} \frac{1-\mu}{\mu} (1-Q_{\text{out}}) \times$$

$$\left(-c - (b-c) \left(\frac{(1-m)^2}{n} + \frac{m^2}{n(N_d-1)} \right) - c \right)$$

$$+ \frac{Q_{\text{in}} - Q_{\text{out}}}{1 - Q_{\text{out}}} \left[b - (b-c)(n-1) \left(\frac{(1-m)^2}{n} + \frac{m^2}{n(N_d-1)} \right) \right] \Bigg)$$

Expected frequency of altruists in the population

Mutation-drift equilibrium Selection strength Variance in the state of one site

$$\mathbb{E}[\bar{X}] = \underbrace{\nu}_{\text{Mutation-drift equilibrium}} + \underbrace{\delta}_{\text{Selection strength}} \underbrace{\nu(1-\nu)}_{\text{Variance in the state of one site}} \frac{1-\mu}{\mu} (1-Q_{\text{out}}) \times$$

$$\left(\underbrace{-c - (b-c) \left(\frac{(1-m)^2}{n} + \frac{m^2}{n(N_d-1)} \right)}_{\text{purple box}} - c \right.$$

$$\left. + \frac{Q_{\text{in}} - Q_{\text{out}}}{1 - Q_{\text{out}}} \left[\underbrace{b - (b-c)(n-1) \left(\frac{(1-m)^2}{n} + \frac{m^2}{n(N_d-1)} \right)}_{\mathcal{B}} \right] \right)$$

Expected frequency of altruists in the population

Mutation-drift equilibrium
 Selection strength
 Variance in the state of one site

$$\begin{aligned}
 \mathbb{E}[\bar{X}] = & \underbrace{\nu}_{\text{Mutation-drift equilibrium}} + \underbrace{\delta}_{\text{Selection strength}} \underbrace{\nu(1-\nu)}_{\text{Variance in the state of one site}} \frac{1-\mu}{\mu} (1-Q_{\text{out}}) \times \\
 & \left(\underbrace{-c - (b-c) \left(\frac{(1-m)^2}{n} + \frac{m^2}{n(N_d-1)} \right)}_{\text{purple box}} - c \right. \\
 & \left. + \underbrace{\frac{Q_{\text{in}} - Q_{\text{out}}}{1 - Q_{\text{out}}}}_{\mathcal{R}} \left[\underbrace{b - (b-c)(n-1) \left(\frac{(1-m)^2}{n} + \frac{m^2}{n(N_d-1)} \right)}_{\mathcal{B}} \right] \right)
 \end{aligned}$$

Expected frequency of altruists in the population

Mutation-drift equilibrium Selection strength Variance in the state of one site

$$\mathbb{E}[\bar{X}] = \underbrace{\nu}_{\text{Mutation-drift equilibrium}} + \underbrace{\delta}_{\text{Selection strength}} \underbrace{\nu(1-\nu)}_{\text{Variance in the state of one site}} \frac{1-\mu}{\mu} (1-Q_{\text{out}}) \times$$

$$\left(\underbrace{-c}_{\text{purple}} - (b-c) \left(\frac{(1-\text{sword } m)^2}{n} + \frac{m^2}{n(N_d-1)} \right) \right) - c$$

$$+ \underbrace{\frac{Q_{\text{in}} - Q_{\text{out}}}{1 - Q_{\text{out}}}}_R \left[\underbrace{b}_{\text{green}} - (b-c)(n-1) \left(\frac{(1-\text{sword } m)^2}{n} + \frac{m^2}{n(N_d-1)} \right) \right] \Bigg)$$

R
 B

