

Summary

Introduction

Materials and Methods

Basic explanation of the models. We modeled a stage-structured population in two stages: immatures and matures. The demography is given by a transition matrix, with...

Under constant environment

Using Lande (2009), under weak selection we have:

$$\Delta \bar{z} = \frac{d \ln \bar{\lambda}(\bar{z})}{d \bar{z}} = \frac{1}{\bar{\lambda}(\bar{z})} \frac{d \bar{\lambda}(\bar{z})}{d \bar{z}} \quad (1)$$

And we have:

$$\begin{aligned} \bar{\lambda}(\bar{z}) &= \sum_{i,j} v_i u_j \bar{a}_{ij} \\ &= v_I u_I \bar{a}_{II} + v_I u_M \bar{a}_{IM} + v_M u_I \bar{a}_{MI} + v_M u_M \bar{a}_{MM} \end{aligned}$$

With \bar{a}_{ij} the expected values of the coefficient of the transition matrix. Thus,

$$\begin{aligned} \bar{\lambda}(\bar{z}) &= v_I u_I [\bar{f}_1(\bar{z}) m s_0 + (1 - m) \bar{s}_I(\bar{z})] + v_I u_M s_0 \bar{f}_2(\bar{z}) \\ &\quad + v_M u_I m s_M + v_M u_M s_M \end{aligned} \quad (2)$$

$$\frac{d \bar{\lambda}(\bar{z})}{d \bar{z}} = v_I u_I \left[\frac{d \bar{f}_1(\bar{z})}{d \bar{z}} m s_0 + (1 - m) \frac{d \bar{s}_I(\bar{z})}{d \bar{z}} \right] + v_I u_M s_0 \frac{d \bar{f}_2(\bar{z})}{d \bar{z}} \quad (3)$$

Because f_i and s_I are gaussians we can write the population means \bar{f}_i and \bar{s}_I easily.

$$\bar{f}_1(\bar{z}) = f_1(\theta_f) \sqrt{\frac{\omega_f}{\omega_f + P_I}} \exp \left(-\frac{(\bar{z} - \theta_f)^2}{2(\omega_f + P_I)} \right) \quad (4a)$$

$$\bar{f}_2(\bar{z}) = f_2(\theta_f) \sqrt{\frac{\omega_f}{\omega_f + P_M}} \exp \left(-\frac{(\bar{z} - \theta_f)^2}{2(\omega_f + P_M)} \right) \quad (4b)$$

$$\bar{s}_I(\bar{z}) = s_I(\theta_s) \sqrt{\frac{\omega_s}{\omega_s + P_I}} \exp \left(-\frac{(\bar{z} - \theta_s)^2}{2(\omega_s + P_I)} \right) \quad (4c)$$

Thus we can derive these expression with respect to \bar{z} :

$$\begin{aligned} \frac{\partial \bar{f}_1(\bar{z})}{\partial \bar{z}} &= f_1(\theta_f) \sqrt{\frac{\omega_f}{\omega_f + P_I}} \frac{\partial \exp \left(-\frac{(\bar{z} - \theta_f)^2}{2(\omega_f + P_I)} \right)}{\partial \bar{z}} \\ &= f_1(\theta_f) \sqrt{\frac{\omega_f}{\omega_f + P_I}} \exp \left(-\frac{(\bar{z} - \theta_f)^2}{2(\omega_f + P_I)} \right) \frac{\theta_f - \bar{z}}{\omega_f + P_I} \\ &= \bar{f}_1(\bar{z}) \frac{\theta_f - \bar{z}}{\omega_f + P_I} \end{aligned} \quad (5)$$

We obtain similar formulas for \bar{f}_2 and \bar{s}_I . Plugging (5) into (3) we have:

$$\frac{d\bar{\lambda}(\bar{z})}{d\bar{z}} = v_I u_I \left[\frac{\theta_f - \bar{z}}{\omega_f + P_I} m s_0 + (1 - m) \frac{\theta_s - \bar{z}}{\omega_s + P_I} \right] + v_I u_M s_0 \frac{\theta_f - \bar{z}}{\omega_f + P_M} \quad (6)$$

Using (6) into (1) gives us after rearranging: We have for variations of phenotype, under weak selection:

$$\Delta \bar{z} = (\theta_f - \bar{z}) \left[\frac{v_I u_I G_I s_0 m \bar{f}_1}{\lambda(P_I + \omega_f)} + \frac{v_I u_M G_M s_0 \bar{f}_2}{\lambda(P_M + \omega_f)} \right] + (\theta_s - \bar{z}) \left[\frac{v_I u_I G_I \bar{s}_I (1 - m)}{\lambda(P_I + \omega_s)} \right] \quad (7)$$

Within the square brackets, we see weighting average of fecundity and survival. Thus, we define them as γ_f and γ_s such as:

$$\gamma_f = \frac{v_I u_I s_0 m \bar{f}_1}{\lambda(P_I + \omega_f)} + \frac{v_I u_M \frac{G_M}{G_I} s_0 \bar{f}_2}{\lambda(P_M + \omega_f)} \quad (8a)$$

and

$$\gamma_s = \frac{v_I u_I \bar{s}_I (1 - m)}{\lambda(P_I + \omega_s)} \quad (8b)$$

We end up having a simpler expression for $\Delta \bar{z}$ under constant environment:

$$\Delta \bar{z} = -G_I [\gamma_f (\bar{z} - \theta_f) + \gamma_s (\bar{z} - \theta_s)] \quad (9)$$

Under varying environment

From Engen et al. (2011), we derived equations for mean variation of phenotype on our model.

We supposed an auto-correlated fluctuating environment influencing optimum such as $\theta_f = \bar{\theta}_f + \alpha_f \epsilon_t$. With $\epsilon_{t+1} = (1 - \rho)\bar{\epsilon} + \rho\epsilon_t + \xi$ with ξ a gaussian noise vector with variance σ_ξ^2 and mean 0.

Results

Subheading1

Subheading2

Discussion

Authors Contributions and Acknowledgments

References

(Barfield et al., 2011)

References

Barfield, M., Holt, R. D. and Gomulkiewicz, R. (2011). Evolution in Stage-Structured Populations (2 versions). *The American Naturalist* 177, 397--409.

Engen, S., Lande, R. and Sæther, B.-E. (2011). Evolution of a Plastic Quantitative Trait in an Age-Structured Population in a Fluctuating Environment. *Evolution* 65, 2893--2906.

Lande, R. (2009). Adaptation to an extraordinary environment by evolution of phenotypic plasticity and genetic assimilation. *Journal of Evolutionary Biology* 22, 1435--1446.