The Breeder's Equation (Stephanie Sjoberg, Nikayla Strauss, and Dylan Larkin)

Introduction

- The origins of the breeder's equation are fairly ambiguous.
- Three researchers played influential roles in the development of the equation. These researchers are Karl Pearson, Dr. Jay Lush, and Dr. Russell Lande.

Breakdown of Breeder's Equation

- $R=h^2S$ R=response to selection, the difference between the mean of the population before selection and the mean of the offspring h^2=heritability, scaling factor S=selection differential, difference between the mean of the population and the mean of the population that reproduces
- Heritability can be narrow sense (Va/Vp), proportion of genetic variation that is due to additive genetic values or broad sense (Vg/Vp), Proportion of phenotypic variation due to genetic values that include the effects of dominance and epistasis. Narrow sense should be used for plant and animal systems
- The equation can be used for univariate or multivariate analysis. Multivariate analysis uses the same equation but in matrix form to allow for analysis of multiple correlated traits

Applications

- Genetic Achievements in Animal and Plant Breeding
    - Milk yields of US Holstein cows has increased by nearly 100% since 1957
    - Oil content in corn has been manipulated in both directions via artificial selection
- Indirect Selection as Evolutionary Force
    - Lande (1979) looked at the relationship between brain size and body size, and found that selection on one trait will also change the other (aka indirect selection)
- Selection Differentials and Selection Gradiants
    - In a study of stink bugs' fitness and physiological traits associated, Lande & Arnold (1983) showed that observed change in mean phenotype within a generation may be a very poor indicator of the actual forces of selection estimated by the selection gradient
- Breeder's Equation vs. Robertson-Price identity
    - Morrissey et al. (2010) concluded that the relationship between fitness and genes must be the same as the relationship between fitness and phenotypes in order for predictions of the breeder's equation and the Robertson-Price identity to be the same

Citation

Hill, W. G. (2010). Understanding and using quantitative genetic variation. Philosophical Transactions of the Royal Society of London B: Biological Sciences, 365(1537), 73-85.

Lande, R. (1979). Quantitative genetic analysis of multivariate evolution, applied to brain: body size allometry. Evolution, 402-416.

Lande, R., & Arnold, S. J. (1983). The measurement of selection on correlated characters. Evolution, 1210-1226.

Lande, R., & Arnold, S. (2016, December 3). *Multivariate Quantitative Genetics*. Lecture.

Lively, C. (2016, December 4). *Basic Quantitative Genetics*. Lecture presented in Indiana University.

Lush, J.L. (1943) Animal breeding plans. Ames, Iowa: The Iowa State College Press.

Morrissey, M. B., Kruuk, L. E. B., & Wilson, A. J. (2010). The danger of applying the breeder's equation in observational studies of natural populations. Journal of evolutionary biology, 23(11), 2277-2288.

Ollivier, L. (2008). Jay Lush: Reflections on the past. Lohmann Information, 43(2), 3-12.