SYLLABUS THEME 2

STUDY UNIT 1: INTRODUCTION

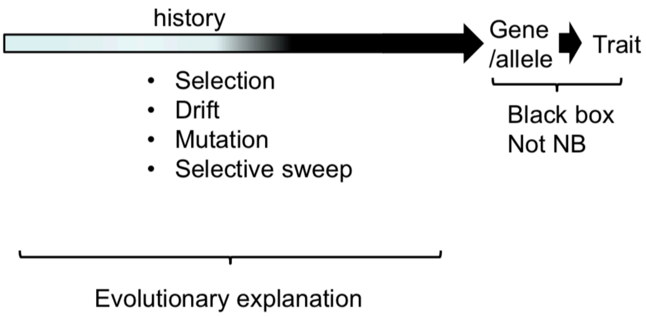
DR GREEF NOTES EVOLUTIONARY GENETICS INTRO

LECTURE 21

1) EVOLUTIONARY GENETICS

Our aim is to give an evolutionary explanation of traits

- **What are traits?** By trait we mean the phenotype , but we treat some apparent genetic attributes (eg genome size) as a phenotype
- We know that selection and drift are very important forces that change allele frequencies
- Linkage may be an important factor affecting allele frequencies because selection at a fitness-altering site results in selective sweeps that reduce variation at linked loci.
- Mutation is another force that can alter allele frequency

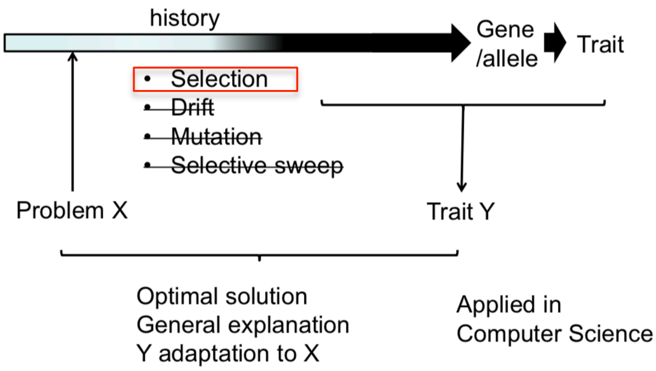


2) SELECTION THINKING AND THE PHENOTYPIC GAMBIT

SELECTION THINKING

The gains of this approach is to lay bare how selection must work

- Especially useful if it is not easy to see what the selective advantage of the trait may be.
- There must be an initial assumption of adaptation in order to make predictions that can be tested as we cannot assme that all traits have an **adaptive value**
- Sometime the answer may simply be that there is no advantage, Lynch argued that complex genomes of higher organisms are the result of a lack of selection and is best explained by drift and mutation.

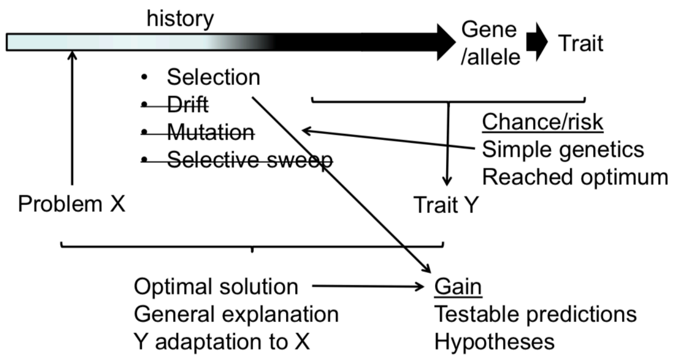


- Selection thinking is so successful that computer scientists routinely use selection in programs written to find optimal solutions to complex problems.
- Reseachers found that a little bit of drift is important to avoid being trapped on local optima=**Shifting balance theory**

PHENOTYPIC GAMBIT

The assumption that traits are adaptations that are optimally 'designed' to improve fitness

- This assumption allows us to make clear predictions of what traits should be like, these predictions can be tested rigorously
- In general a gambit is taking a risk with the hope of making progress – In this case the progress is the ability to make testable hypotheses



The phenotypic gambit forces us to make a number of assumptions simultaneously:

1. We assume the **trait is heritable** with a simple molecular underpinning (eg a single locus with no interaction with other loci)
2. We may even have to **asume haploidy** rather than diploidy
3. We assume that during the trait's evolution, it had heritable genetic variation but the **alleles translate into a phenotype in a simple way** with small effects that are additive and under directional selection
4. We assume that many **so many mutations have occurred** that the most common variant is not simply the best of two alleles but is the best of all posible solutions to the problem
5. We assume that **a long time must have elapsed** since the 'problem' arose and that this time has allowed selection to fix the best alleles
6. We assume the **absence of drift** or that the population sizes are large enough to overpower the effects of drift (Therfore N > s/2)

Most of the time it does not matter that the gambit is not exactly true nor that we don't know which genes are involved – It makes the mathematics simpler

- In general so much time has elapsed and because selection is omnipesent , traits are frequently adaptations
- Another objection – Genetic architecture of traits may be complex with interactions with many other loci and heterozygote advantage
- However, researchers have argued that genes that have too many interactions are not able to evolve to an optimal state and genes with fewer interactions that can evolve more easily will replace such genes.

3) ULTIMATE AND PROXIMATE CAUSES

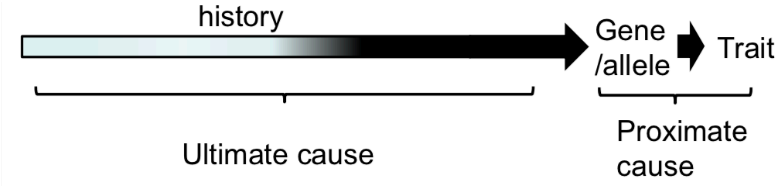
If we predict trait Y as a response to X and we fail to reject the hypothesis a number of times then it seems that evidence is mounting that trait Y is an adaptation to X

Ultimate reason: If we claim trait Y is an adaptation for/to trait X

- Therefore , if asked "What is the ultimate reason for a trait's existence?
- Explain why **selection favoured it**
- Shaped by many generations of selection in the distant past

Proximate reason: What is the reason for Y?

- Mechanistic explanation for a trait
- Phylogenetic , historical and ontogenetic
- Historic/Phylogenetic answer: this individual has a trait because one of its parents, or the ancestral species, had it.
- Ontogenetic answer: imprinting and heterochromatization
- Happened in the very near past



Example:

- **A proximate reason** for why differentiated cells cannot divide forever would be because their telomeres get shorter after each division.
- **An ultimate reason** would require an explanation of why this may be of benefit.
- For instance, if cells cannot divide forever because it prevented cancerous growths. Shortening of telomeres could thus be one proximate mechanism to attain the ultimate goal of protection against cancer.

4) EXAPTATION

We must not confuse **current use** and **past benefits** of a trait

- We frequently confuse current use of a trait with the reason why it increased in frequency in the first place, but these need not be the same.
- A trait may not even be an adaptation but it may serve a specific purpose.

Exaptation: situations where traits that are already fixed are co-opted for alternative functions or become functional.

- For example: A current use of a nose is to hold up a pair of glasses, however, this is not why noses evolved in the first place
- If cell line mortality evolved for a completely different reason other than to prevent cancers, or is just the result of drift, we can say that it is now an exaptation to prevent cancers.