Lecture 5 - F Statistics

Inbreeding

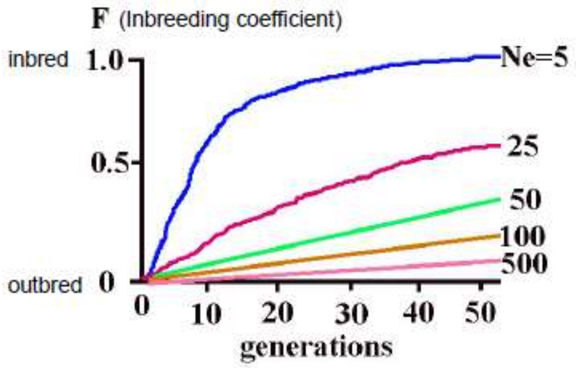
F is the inbreeding coefficient = the probability of autozygosity
Autozygosity - alleles that are identical by decent
0 (outbreed) to 1 (autozygous at every locus)

If we go back 10 generations, the minimum population necessary is <u>1024</u> to share no common ancestors. Many populations are smaller than this.

An inbred population cannot be restored by just increasing the census size.

- Genetic diversity must increase (migration)
- Effective population must increase (faster variation)

Small Ne populations become inbred very fast, but large populations are become inbred very slowly.



Heterozygosity (h)

When inbreeding increases, heterozygosity decreases. F can be estimated by heterozygosity.

Observed heterozygosity of inbred population

$$F = 1 - (H_{inbred} / H_{outbred})$$

Expected number of heterozygotes in population at HWE

in the absence of mutation & selection

Swedish Grey Wolves are not endangered, but the packs live in fragmented habitats in small populations.

Two levels of inbreeding (increased autozygosity):

<u>'Deliberate' mating</u> between relatives - e.g. spiders

- High individual F values can occur in large populations.
- Can be avoided by behavioural mechanisms

<u>'Accidental' mating</u> due to small population size - loss of genetic variation by drift

- Small population size
- Occurs even when individuals actively try to avoid mating with relatives

Behavioural methods to prevent inbreeding:

- Pack animals kick out young males (kangaroos)

Inbreeding is about the **genotype frequencies** and **not the allele frequencies**

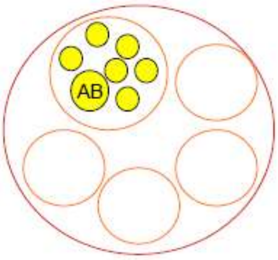
Other F's

F = fixation index - how alleles are packed into individuals

F-STATISTICS CAN BE AT THREE HIERARCHICAL LEVELS.

Hierarchy of variation

- Alleles in individuals
- Individuals in subpopulations
- Subpopulations in populations



Three types of H in a hierarchy:

H_I – observed Individual H within subpops

H_S – expected individual H within Subpops

H_T – expected individual H in Total pop

F measures the departure from HWE

F_{IS} - Individuals within subpopulations

$$F_{IS} = (H_S - H_I) / H_S$$

-1 = all heterozygotes - (from outbreeding, recent admixture, selection etc.).

0 = HWE

+1 = all homozygotes - (from inbreeding, separated groups, cryptic species etc.).

Are individuals panmictic? (deviate from random mating).

Measure inbreeding

F_{ST} - Subpopulations within populations

$$F_{ST} = (H_T - H_S) / H_T$$

0 = no difference between subpopulations

+1 = fixed differences (different species)

<0.05	Little differentiation
0.05-0.15	Moderate
0.15-0.25	Great
>0.25	Large difference

Measure gene flow

F_{IT} - Individuals within populations

Related to F_{IS} and F_{ST}

The individuals in the total population

$$(1- F_{IS})\ (1- F_{ST}) = (1- F_{IT})$$

Wahland Effect

The sampling level must be correct. Incorrect results (+ve F_{IS}) will come from 2 subpopulations treated as two, or two groups of cryptic species.

Lecture 13 - Hybridization

Learning Objectives

• Using correct terminology, discuss the many ways in which hybridisation can act as post-mating reproductive isolating barrier and, conversely, as a pathway for speciation.
• Explain how hybridisation fits within the frame work of phylogenetic reconstruction.

Definition for these lectures:

Interbreeding between species (Grant and Grant 1992)

Broader definitions exist.

Hybridisation in Animals

Traditionally thought of as an evolutionary dead-end.
But...many hybrid animal species can be found.

Hybridisation in Plants

More than 70% of plants are descended from hybrids.
Very important in plant evolution.

Inter<u>specific</u> (natural) hybrid - within the same genus
Inter<u>generic</u> hybrid - between genera

Plants that hybridise tend to be:

- Perennials (not seasonal, live for years)
- Outcrossers
- Pollinated by insects
- Able to reproduce asexually

Evolutionary Consequences of Hybridisation

5 potential consequences:

1. **Reinforcement of reproductive isolating mechanisms**

- As a post-mating reproductive barrier
  - <u>Hybrid inviability</u> - offspring not born/reaching reproductive maturity or have different habitat requirements
  - <u>Hybrid floral isolation</u> - lack of pollinators suited to the hybrid

    - Hybrid sterility - no offspring, failure to pair at meiosis
        - Partial hybrid sterility - the F1 generation is poor, but when backcrossed with parent, the offspring are stronger than ever.
    - Hybrid breakdown - future generations have difficulties that prevent genes being passed on
    - Heterosis (hybrid vigour) - the fitness of hybrids

2. **Introgression**

- Permanent incorporation of genes of one species into another

Consequences of introgression:

- The merging of different species
- Transfer of genetic material (without merging)
- Form hybrid swarms and new taxa (if stable)

3. **Hybrid swarm formation**

- A mess of hybrids
- Loss of biodiversity can occur if an organism is lost in a hybrid swarm

4. **Creation of genetic diversity and adaptation**
5. **Evolution of new species**

Lecture 2 - Sexual Selection

Male traits sometime appear to be a disadvantage.
Extreme displays can decrease survival but increase mating success.

Only male frogs make vocal calls.

With sex, the most productive system is to have many small gametes that find the few large gametes. Chance of survival is higher.

Females have a high investment strategy
Males have a high mating strategy

SEXUAL SELECTION

- Intra-sexual selection - male to male competition
- Inter-sexual selection - female choice

Not mutually exclusive

Intra-sexual selection - male to male competition

- Combat
- Sperm competition
- Infanticide

Inter-sexual selection - female choice

- Direct selection on preference genes
    - When the preference for a male trait increases the females fitness
        - E.g. Gifts, territory or protection
- Indirect selection on preference genes
    - Correlated with another male trait under selection.
    - The offspring get the preference and the males trait

Lecture 12 - Cooperation and Conflict

Altruism: behaviour that decreases the fitness of the actor and increases the fitness of the recipient.

Evolution of Cooperation

- Byproduct
- Shared alleles
- Reciprocity

B = fitness benefit
C = fitness cost

COOPERATION BY BYPRODUCT
Helping others is a byproduct of a selfish action.
Operates within or between species
E.g. Dung beetles
C=0
Cooperative behaviour but not altruistic.

SHARED ALLELES
An action to benefit another individual with the same alleles. Beneficial to the species.
Don't have to be kin, but must be the same species.
E.g. Slime molds

Altruism can evolve if the benefit to relatives is greater than the cost = Hamilton's Rule

RECIPROCITY
The action is reciprocated.
Within or between species

Direct reciprocity: two partners
  Possibility the favour will not be returned
Indirect reciprocity: social networks
  Unique to humans

CONFLICT

Cheating behaviour
Some alleles are able to take advantage over organisms with altruistic alleles.
E.g. A strain of slime mold swarm up the fruiting body in the lab.
Cheater alleles exist, but altruistic alleles are predominant because cheater alleles have a hard time in nature.

Antagonistic Coevolution - Evolutionary Arms Race

- Predator defense
- Arms race

The fighting ends when one species evolves an unbeatable adaptation.