GENETICS OF MARINE DIVERSITY

JULY 20 – AUGUST 3, 2009
BIOSM 4720 4 Semester credits

PREQUISITES: One full year of college level biology or permission of the instructor. Students who have taken this course: students who went a basic course in molecular genetic techniques, students who are familiar with the techniques but want a course in field application, any student with an interest in evolutionary genetics.

FACULTY: Dr. Andrew Shedlock, Museum of Comparative Zoology, Harvard University

COURSE DESCRIPTION: A basic introduction to the application of molecular genetic techniques to problems in marine biology. DNA, organisms and their environment and inheritance of molecular information across generations will be introduced.

Why are species so similar or so different? Biological diversity reflects a complex interplay between genetics, evolution, and environment and inheritance of molecular information across generations.

Can be used to clarify species status
- Genetic variability is needed to respond to environmental change
- Heterozygosity or high genetic variability is beneficial, positively related to fitness
- Genetic diversity, as it is represented by the genes of all species, contains all information for all the biological processes like a large library.

Genetics in Conservation

2 out of 4 loci are polymorphic:

\[ P = \frac{2}{4} \]

Observed heterozygosity

Frequency of heterozygote individuals per locus:

Average over number of sampled loci:

\[ \frac{0.4 + 0.2 + 0.0 + 0.0}{4} = \frac{0.6}{4} = 0.15 \]

Alllic diversity

Average number of alleles per locus (average over all sampled loci):

\[ \frac{2 + 4 + 1 + 1}{4} = 2.0 \]

Polymorphism

Frequency of the loci with more than 1 allele:

\[ P = \frac{2}{4} \]

Allelic diversity

Average number of alleles per locus (average over all sampled loci):

\[ \frac{2 + 4 + 1 + 1}{4} = 2.0 \]

Genetic data can be used to clarify species status

Kemp’s Ridley Turtle

Olive Ridley Turtle

http://www.sml.cornell.edu/DEADLINE February 15th

CONTACT: shedlock@oeb.harvard.edu
Variability is important

Variation of phenotype can be due to genotype and environment

\[ V_{\text{Phenotype}} = V_{\text{Genotype}} + V_{\text{Environment}} + V_{\text{GE}} \]

Variability is important

Evolution (through natural selection) results in a change of allele frequencies over time

Genetic variation is important

The specific phenotype could do best at a specific temperature, temperature changes will wipe out the population where the individuals are ill adapted.

Individual Heterozygosity

Population size

- Number of individuals in a population tells us whether we need to be concerned about the future of the population. How to measure?
  - **Census population size**: total number of individuals in a population
  - **Effective population size**: total number of individuals that contribute to future generations

Modeling populations

- \( N \) haploid individuals
- assign each individual an allele, for example \( A \) or \( a \)
- each individual produces lots and lots of gametes
- new \( N \) individuals are picked randomly out of that gamete pool
Modeling populations

Model population through time

Random Genetic Drift

Random Genetic Drift

Random Genetic Drift

Random Genetic Drift

PopG demo
Program from
http://evolution.gs.washington.edu/popgen/popg.html
Random genetic drift

Population size is an important number

- A random-mating population of diploid individuals loses by chance alleles, it loses at a rate of $1/(2N)$ where $N$ is the number of diploid individuals:
- Small populations lose alleles faster than large populations,
- If the population is infinitely large then the frequency of different alleles stays the same.