Problem Set #2

Problems Ch. 2 # 1-4,6,7

And

1. Define macro- and microevolution. What is the conceptual connection between the two?

   Microevolution is change in allele frequency from one generation to the next. Macroevolution is Darwin's descent with modification, alternatively large changes in form over time. A Neo-Darwinian tenet is that macroevolution is just lots of microevolution.

2. List two problems with Lamarck's alternative to natural selection as an explanation for adaptive evolution.

   Inheritance of acquired characters requires the flow of information from trait to the genetic material. This is demonstrably incorrect.

   The theory is progressive; it requires that the organism anticipate what trait or behavior is adaptive. For example, for the giraffe to get a longer neck, it must be trying to get a longer neck.

3. What scientific discovery ultimately lead to widespread recognition of the fundamental importance of evolution by natural selection? Why did early Mendelians nevertheless resist the idea?

   Rediscovery of Mendelian genetics solved the problem of inheritance. Successful incorporation of genetics into the theory of natural selection resolved many outstanding conceptual issues, including the problem of blending inheritance, and what a mutation is.

   Early Mendelians were initially impressed by the power of mutations to change an organism's form; thus

resemblance between parent and offspring seemed irrelevant to the most important changes in the organism. Rsemblance between parent and offspring (non-zero heritability) is necessary for natural selection to operate.

4. Why are fossils a bonus? That is, why is evidence for evolution overwhelming even if we had none?

DNA sequences provide a vast number of evolutionarily homologous traits which independently corroborate inferences about phylogeny (evolutionary relationships between organisms) from morphological characters and the fossil record.

5. The incorrect depiction of evolutionary relationships of organisms as a function of their position along an evolutionary ladder suggests that some organisms (lower taxa) are less evolved than others (higher taxa). Assume for the sake of argument that higher organisms are in fact more complex than low ones by some objective measure, for example, the number of genes in the genome. Given that the correct evolutionary relationships are actually described by a phylogeny, provide a counter argument to the idea that "lower" organisms are less evolved than "high" ones.

Drawing a phylogeny as a branching tree, with the tips rising toward the present, shows that all current taxa, whether high or low, have been evolving for an equal amount of time. There is no evident difficulty in natural selection resulting in increased complexity, if this increases fitness. The difficulty lies in suggesting that natural selection has a particular goal, since it is incapable of anticipating what may be advantageous in the future.

Ch. 2 #1-4, 6, 7

#1. Evidence available to Darwin:
Some examples of vestigial structures
The fact of extinction
The law of succession in the fossil record
Structural homology
Developmental homology
The occurrence of closely related species in groups of islands
Age of Earth known to be much greater than 6,000 years (but absolute dates not known)

Not available to Darwin:
Many more examples of all the above
Transitional fossil forms
Direct observation of populations in the wild changing through time (however, Darwin did know about, and paid close attention to, the changes that animal breeders can cause in domestic animal populations)
Ring species
Genetic and molecular information of any kind, including vestigial molecular traits, molecular homologies, and basic genetics
Radiometric dating and absolute dates for the geologic time scale

#2. The answer to this question is entirely subjective and is left to the reader. For perspective, however, we can offer that the discovery of Archeopteryx was quite influential and convinced many people, both scientists and laypeople, that the theory of common ancestry was probably correct. However, most people, including biologists, doubted that natural selection was a significant factor in evolution until the "modern synthesis" of the 1930s united genetics with natural selection.

#3. Many different approaches are possible. Anatomical traits of dogs or cats (e.g., snout length in dogs, ear shape, leg length, and so on), could be traced through time examining archeological remains of the domesticated dogs and cats throughout history, and assessing whether the anatomical changes appear to lead back to the putative wild ancestor. The question can also be tested with molecular data-for example, by comparing DNA sequences in modern dogs and cats and in wild canids and felids.

In either case we would use the data to construct a phylogenetic tree, as discussed in further detail in later chapters. If all modern breeds are descended from a common ancestor, the phylogeny should show that all modern breeds are more closely related to the purported wild ancestor than to any other wild canid or felid. Furthermore, the modern breeds should show a branching phylogeny indicating the pattern and relative timing of their divergence from each other.

#4. Many answers are possible. Several examples that paleontologists are eager to find are: a common chimp-human ancestor from approximately 7-8 mya (just before the hypothesized split of chimps and humans); a transitional bat fossil showing incipient development of bat wings; a transitional turtle fossil demonstrating an intermediate stage in development of the turtle shell; and very early representatives of the major animal phyla. (Some possible examples of these cases have been discovered, but are still controversial.)

The fossil record is a case of "Absence of evidence is not evidence of absence." Many species do not leave any discoverable fossils at all, due to such factors as our lack of access to deeply buried strata and the complete destruction of large sections of the earth's crust in subduction zones. Thus, presence of a fossil obviously proves that the predicted species once existed, but absence of known fossils does not prove that it did not exist.

6. Under the modern definition of homology, a kiwi's wing is homologous to an eagle's wing, and the rubber boa's spurs are homologous to a kangaroo's hind legs. Owen's classical definition is only applicable if the organs are subjectively judged to be "the same organ." Owen would likely have agreed that a kiwi's wing and kangaroo's wing are the same organ, but he might not have perceived the rubber boa's spurs as being essentially the "same organ" as a quadruped's hind legs.

7. a. analogous
   b. The front limbs of a porpoise are evolutionarily derived from the same structures giving rise to a fishes fin, so the two are homologous. The fact that both are used for swimming is actually an analogous similarity, since the porpoise flipper was derived from the terestrial tetrapod

limb.
c. analogous
d. homologous
e. homologous
f. analogous