

Evolutionary Concepts

I. The Theory of Evolution

Evolution is a theory that explains the origin and development of life on earth. Organisms change over time and can develop into new organisms through the process of evolution. Evidence for evolution is found in the fossil record, and is supported by observations of the following processes: natural selection, genetic variation, mutation and sexual selection.

- a. **Natural selection:** Natural selection is based on the concept of survival of the fittest. This means that those individuals who are the best suited to their environment will survive to reproduce and pass on their genes to the next generation. Those who are less suited to their environment will die without passing on their genes. Over time, certain genes survive and other genes are weeded out of the population. This is an ongoing process; there is no end to natural selection. Plants and animals alive today are still subject to natural selection. Thus it is important to remember that:

Natural selection = survival of the fittest

- b. **Genetic variation:** Sexual reproduction creates genetic diversity in a population. What does that mean? When male and female gametes, like sperm and eggs, are formed, each gamete contains one set (half) of the genetic material of its parent. When these gametes fuse, together they make an entirely new, unique individual with some genetic material from the mother and some genetic material from the father. No two individuals created by sexual reproduction will be exactly alike, just like all humans have different characteristics even though we are all members of the same species. This is genetic variation.



Snails of the same species, showing genetic variation

Now we know what genetic variation is, why is it so important? The more variation you have in a population, the more likely it is that at least some members of the population will survive any dramatic environmental changes. As an example, many farmers get frustrated that pesticides are not always 100% effective and often become completely ineffective after a few years of repeated use. One reason for this is that in any given insect

population, it is likely that there are at least a few individuals who are resistant to a pesticide. So, for instance, out of 1000 beetles, there may be 2 who have genes that cause them to be resistant to the pesticide. When the farmer sprays his fields, 998 of the beetles will die and the two resistant ones will survive. When they mate, many or all of their offspring will have the gene for pesticide resistance and after a few new generations have reproduced; the whole population of beetles will be resistant. The farmer is then forced to find a new chemical to control the beetles. Therefore:

More variation = better chance of species survival

- c. **Mutation:** Mutations are rare and occur when a gene alters itself for no apparent reason. Mutations are the original source of all genetic diversity. Mutations can be harmful, neutral or helpful. Harmful mutations hinder the survival of the individual or cause death. In this case, the individual usually dies before they can reproduce and thus the mutated gene dies with him or her. Some mutations are neutral, meaning that they neither help nor hinder the individual. In this case, the individual may survive to reproduce and pass on the neutral mutated gene. Sometimes the mutation turns out to be beneficial, meaning the mutation helps the individual survive in their environment. In this case, the individual will likely reproduce and pass the new gene on into future generations. Therefore:

Mutations = the original source of all genetic variation

- d. **Sexual selection:** There are some adaptations that seem to contradict natural selection. For instance, why does a male peacock have such bright feathers? Doesn't that make him more obvious to predators? The answer is yes; it does make him more obvious to predators. Why, then, did the peacock evolve such a grand display? Many male birds develop brilliant feathers to attract females as mates even though those feathers are a dead giveaway to predators. If the female peacocks do not find the male attractive, he will likely not mate. Although he may survive until old age, his genes may not be passed on. The males that have the brightest feathers are the ones who will get to mate, and thus their offspring are more likely to have bright feathers too, even if this might mean they die at a slightly younger age. Sexual selection is not driven by forces in the environment like natural selection, but by what females or males find attractive. What the female finds attractive might not always be in the best interest of the male's long term survival, but if a male does not mate, his genes die when he does. Therefore:

Reproduction is as important as survival in the evolutionary context.

Sexual selection does not apply as clearly to plants as it does to animals. However, just like the bright feathers of birds, some plants have developed ways to attract pollinators to them with bright, beautiful flowers, sugary nectar or scents. Plants don't need to be attractive to other plants, but they do need to be attractive to their pollinators. Some flowers have therefore evolved based on the preference of their pollinators.

II. Coevolution

Some animals and plants evolve together in a process called coevolution. Coevolution happens when two different species are closely dependent on each other and interact with each other on a regular basis, so that the evolution of one affects the evolution of the other. A great example of this is flowering plants and pollinators. Most plants have evolved along with the pollinators that they depend on for reproduction, and the pollinator is dependent on the plant for food. Some species have coevolved so closely that one cannot survive without the other. Flowers have evolved specific shapes, colors and smells that attract specific pollinators, and in turn pollinators have developed preferences for specific flowers.

Example of co-evolution: The yucca moth has co-evolved with the yucca plant. The moth lays its eggs inside the ovaries of the yucca flower, and then stuffs the stigma full of pollen. This, of course, pollinates the flower. Although the larvae eat some of the yucca seeds that develop, many seeds survive and may become new plants. This interaction between the moth and the yucca plant is an example of the results of coevolution.



Yucca moth pollinating the yucca flower in order to feed her young