Population Diversity

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No two people are exactly alike, not even identical twins. The same situation obtains in most species in the living world. What accounts for this, and why are things so? The answer has to do with survival of species and evolution.

The appearance of an organism (that can be noticed by humans) is called the organism's phenotype. One aspect of the plant phenotype would be flower color, such as in the four-o'-clock (*Mirabilis jalapa*, a caudiciform) normally bearing red or yellow pigment. On occasion individuals lack pigment and produce white flowers. These white-flowered plants are noticeably paler than the red-flowered plants.

Plant pigment is produced by special proteins called enzymes, acting in sequence on plant chemicals to convert them to other chemicals. If any of the enzymes completely fail to function, no pigment can be produced. If one individual's enzymes function at a greater capacity than another's does, extra pigment is produced. Thus, some roses are dark red and some pink. Every phenotypic characteristic is produced by the action of enzymes.

Proteins are produced in each cell from blueprints in the DNA of that cell. A gene is a region of DNA that codes for one specific protein. A given gene always produces the exact same protein. Mutation results if the gene is changed in any way. The protein produced by that changed gene may be different from normal. It may function worse, better or not much different from the normal protein. It may function optimally at a different temperature than the normal protein. It may not function at all. If the protein does not function at all, and the product is necessary for the organism's survival, the mutation is lethal and the organism cannot survive. If the changed protein functions slightly differently but still adequately, the organism may survive and pass the slightly different protein on to its offspring.

If the organism has more than one functional copy of a gene, it may tolerate one defective copy that would be lethal if it were the only copy available. If an offspring of this organism receives non-functional copies of a gene from both parents, the offspring cannot survive. All organisms contain defective genes, and this is why inbreeding is detrimental to populations.

Over much time, as non-lethal mutations accumulate, a large population will have many variations in almost all the proteins in the population. We say there is great genetic diversity in the population. An example from humans is blood grouping. Certain proteins attached to red blood cells are somewhat variable. The variability doesn't affect survival of humans. Some people have protein type A only. They are blood type A. Others have type B only. They are blood type B. Some have both, and blood type AB. Others lack the protein entirely and are blood type O.

When environmental conditions change, some organisms may be better able to withstand the change than others may. Suppose the temperature increases. In a one-species population with much genetic variability, some plants will have photosynthetic enzymes that function better at cool temperatures, and some better at warm temperatures. If the climate changes enough, the cool-optimized plants may not survive, and only the warm-optimized plants survive. This would be an example of natural selection. If there is little diversity in a population, it will be less likely to survive drastic environmental changes because there will be fewer individuals whose different proteins might still allow survival.

Suppose a population had been reduced to only a few individuals, perhaps by human collection. Suppose that, by chance, all the individuals able to adapt to colder weather have been removed. Suppose the climate now changes for the colder. The natural population will become extinct.

Cheetahs exist in two populations in Africa. All cheetahs are genetically identical to each other. Skin grafts from one cheetah to another take readily, which does not happen in any other mammal. Computer modeling suggests cheetahs were reduced down to seven or fewer individuals at one point, which accounts for the low variability.

Of course, to preserve the full range of genetic variability in a population, the entire population is needed. The number of individuals necessary to preserve enough diversity for a species to survive varies with the number of genes the species has and how many variations in these genes exist. For species with large numbers of genes, many individuals need to be preserved. This is why collections in zoos or greenhouses cannot save species; only habitat preservation will suffice to keep species from extinction. If only a few individuals survive, as with the California condor or the Java rhino, it may not be possible to avoid inbreeding and production of offspring with defective genes from both parents. Then the species will become extinct, as seems probable with the condors and rhinos, and perhaps the cheetah.