88
ARTIFICIAL SELECTION AND NATURAL SELECTION

Darwin returned to England in 1836 and became an accepted member of the scientific community. His journal, *Voyage of the Beagle,* became a best-seller, and he set about reviewing his collected data, thinking about what process could produce the changes in species he was by this time convinced had occurred. He read a now famous essay by Thomas Malthus, which warned (back in 1798) of the explosive growth of human population, and he realized that every species reproduces in such numbers that it will grow explosively until it reaches the carrying capacity of its environment.

Darwin suddenly had the insight that new species developed in nature by exactly the same process that humans had been using since time immemorial to develop more useful varieties of domestic animals and plants. This plate shows the two processes side by side for comparison.

Color the heading Artificial Selection, titles A and B, and the associated structures in the upper left portion of the plate.

In many parts of the world, farmers have problems with badgers stealing their chickens, so hunting badgers is very popular. Centuries ago, farmers in Germany decided that since selective breeding had been useful in improving other kinds of domestic animals and plants, it ought to be able to develop a dog with short enough legs to chase the badger down into its burrow, strong enough paws and claws to dig after the badger, and large enough jaws and teeth to be a match for the badger when it was caught.

Of course, no dog existed with all these characteristics, but of the dogs available, some had shorter legs than the others, some had stronger paws, and so on, so dogs that came closest to the ideal were separated from the other dogs and mated.

Color arrow C and the center left portion of the plate.

Naturally, the ideal dog was not produced immediately, but with the recombination that is a built-in part of the genetic process, a few of the offspring came closer to the ideal and were selected to produce the next generations.

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The farmers continued this process of selection generation after generation. With the passage of *time,* the constant recombination of genes, an occasional mutation, and the constant "selective pressure" of the *breeders* always separating out as breeding stock the dogs with the best badger-hunting traits, the ideal breed for the job eventually developed. It was half a dog high and two dogs long, with short legs, stout paws and claws, and strong jaws: the breed known today as the dachshund (German: *Dachs,* "badger"; *Hund,* "dog").

Color the heading Natural Selection and titles A^1 and B^1 and the associated illustration at the upper right.

Giraffes had always fascinated biologists as outstanding examples of adaptation. Their extremely long necks and long legs, with the front legs longer than the hind ones, adapt them so well to reaching the leaves and tender twigs of the trees on which they feed that they have no serious competitors for that food source. The question was, What made them grow that way?

The answer proposed in 1809 by Jean Baptiste de Lamarck was that as ancestral giraffes reached higher and higher to eat, their bodies responded to an "inner need" and their necks grew longer. These longer necks were then passed on to their offspring, who kept reaching higher, so their necks grew still longer, and so on. Unfortunately, our present-day knowledge of heredity shows this otherwise beautiful theory to be false.

Darwin correctly recognized that variation occurs naturally in all species and that some factor in the environment could perform the same role as a selective breeder, selecting individuals with certain variations to reproduce and preventing, or at least reducing, the reproduction of others. In the case of the giraffe, the *selective factor* would have been the trees, which provided food only for giraffes that could reach high enough.

It seems likely that whenever ancestors of giraffes first found themselves in their present environment, they probably had short necks too, and as long as some leaves and twigs were close enough to the ground, a short neck was no disadvantage. But when the giraffe population reached the carrying capacity of its environment and a food shortage developed—as it always will, sooner or later—giraffes with slightly longer than average necks had a *survival* advantage. If they weren't the only ones to survive, they at least survived in larger numbers.

Color title and arrow C^1 and the remainder of the plate.

With the passage of thousands of years in an environment where any mutation or recombination of existing genes would confer a survival advantage if they made it possible to reach higher on the tree, the giraffes that survived had to be the sort of strange creatures we see today.

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ARTIFICIAL SELECTION☆
BREEDER$_A$
DESIRED PARENTS$_B$
TIME$_C$
RESULT$_D$

NATURAL SELECTION☆
SELECTIVE FACTOR$_{A'}$
SURVIVOR$_{B'}$
TIME$_{C'}$
RESULT$_{D'}$