Letter from the Desk of David Challinor
November 2000

All humans belong to the genus Homo and species sapiens. It is difficult to pinpoint exactly when we separated from other species of Homo; it was undoubtedly a very gradual process, occurring over hundreds of thousands of generations and about a million or more years ago. Homo erectus spread from Africa to Europe and Asia well before sapiens, yet in a relatively short time, evolutionarily speaking, H. sapiens displaced our fellow congeners, including the mysterious Neanderthals, only about 30,000 years ago. No fossils intermediate between Homo species have been discovered, but the fossil sample is still desperately small. As natural hybridization occurs in many other mammals, it may also be discovered eventually in Homo fossils, although the chances are remote. This letter is about the startling frequency of natural hybrids in plants and animals and how such crosses play a role in evolution.

Most species retain their separate identities with physiological and/or physical barriers that separate them from their close relatives. The giant tortoises of the Galapagos Islands are an example. They apparently evolved from a smaller mainland species that probably drifted to these islands on mats of floating vegetation hundreds of thousands of years ago. As the new arrivals colonized different islands, each population adapted to its new environmental conditions. With no predators, they developed the giant form found on other remote islands like the Seychelles. Eventually each island had its own recognizable species or subspecies. Hybrids were minimal as the giant form rarely swam successfully to another island.

Behavioral differences also keep species separate. For example, the American goldfinch is in the same genus (Carduelis) as siskins and redpolls, but hybrids are extremely rare because goldfinches are generally late nesters, waiting until thistles have gone to seed in order to line their nests with thistle down and feed their young the seeds. Thus when goldfinches are hormonally triggered to breed, the adults of their close relatives are no longer in a breeding mode but are helping their young to fledge.

Genetic incompatibility is also a barrier to natural hybridization. Although horses, zebras and asses all belong to the genus Equus, their chromosome numbers are different enough to make their hybrid offspring infertile. Not so for polar bears and brown bears, which evidently evolved relatively recently from a single ancestor. Zoo hybrids are fertile, at least in the two or three generations that resulted from breeding experiments. Practically, such continued breeding would eventually fail because the resulting hybrids would become so inbred they would have trouble reproducing.

Birds frequently hybridize under natural conditions, and crosses are common in geese, ducks, pheasants, gulls and hummingbirds. Most avian hybrids are fertile and often breed with other hybrids or back cross with one of the parent species. Hybrid clutches are often extraordinarily different from each other and cause endless confusion among dedicated birders. Some duck species combinations seem truly bizarre, such as the numerous records of Hooded merganser X Goldeneye or Merganser X Bufflehead. Better known hybrids are the Blue-winged X Golden-winged crosses and back crosses that are common enough to have acquired their own names: Brewster's and Lawrence's warblers.

Chris Jiggins, a visiting scientist at the Smithsonian's Tropical Research Institute in Panama, is studying natural hybridization in Heliconius butterflies. Their caterpillars feed on heliconia leaves, causing the butterfly to be distasteful to many predators. The separate species have distinctive wing patterns, which make potential predators avoid them. However, Jiggins found that 1/4 of all Heliconius butterflies hybridize naturally, violating the conventional wisdom of species separation. Yet a 25% natural hybridization also occurs in ducks and pheasants. Perhaps 10% of all animal species hybridize, and 20% of plant and coral reef fish species also hybridize routinely.

Such hybrids are most common where the ranges of two closely related species overlap and a new niche is available. In fact, the term for such crossbreeding is introgressive hybridization. Examples abound, including two species of iris in the Mississippi delta and two oak species (Q. ilicifolia and Q. marylandica) in eastern U.S. In virtually all cases, the introgressive types become established in areas disturbed by human activity, and if the ecological conditions in these areas remain relatively constant, the hybridization and introgression attains a stable equilibrium. This phenomenon has occurred frequently in the past, quite independent of man's activities. Hurricanes, fires and other natural phenomenon can alter habitats so rapidly that hybrid invaders of closely related species can easily occupy the disturbed habitat. Introgressive hybridization therefore plays a similar role to evolutionary divergence through mutation, recombination and selection. However, it does not produce new morphological characteristics in the sense of progressive evolution, but rather merely causes convergence between previously distinct species. Subspecies can be created in some instances, and they generally survive only as long as the altered habitat endures.

New subspecies' persistence in altered habitats has a useful application in breeding forest trees for use in plantations. These plantations are artificial habitats that endure (with human aid) for at least one rotation of the planted tree crop. Therefore, particularly in Europe where land is at a premium, certain hybrid poplars have the essential hybrid rigor to meet the short rotations of commercial plantations. Poplar lends itself particularly well to experimentation because it easily propagates vegetatively. Thus a particularly desirable strain with good pulping characteristics can be cloned and used to establish plantations in suitable sites.

Even various hybrid pines have demonstrated the vigor that makes them attractive for plantation growth. Pines, however, have to grow from seed, a slower process than rooting cuttings (clones). In hybrid pine plantations, individual trees from the first generation cross ($F_1$) often fail to show the requisite qualities sought by the grower and are therefore culled before they blossom. Even after the harvest of the first rotation, it often pays to leave a few mature trees of the $F_1$ hybrids as a seed source for the next ($F_2$) generation.

What does all this mean to the average citizen? Hybrids, mutants, mongrels and mutts have traditionally been considered inferior to "pure bred" animals, an attitude that may have reached its apogee in the 1930's with Hitler's touted "pure Aryan" as the ideal human morph. The idiocy of this concept has been rejected by most rational people, although it may still survive in remnants of the lunatic fringe. In domestic animals, breeds are only maintained by human control of propagation. However, $F_1$ crosses of Herefords (and other European breeds) with Brahma is still a common practice in southern U.S. to exploit the rapid weight gain of the $F_1$'s. Second generation crosses ($F_2$'s) lose their hybrid vigor, but by careful breeding the King Ranch in Texas produced a 5/8 Shorthorn-3/8 Brahma cross that is now vigorously maintained as a separate cattle breed called Santa Gertrudis.

Even the United States government showed its bias when the Endangered Species Act of 1973 failed to make eligible for inclusion the subspecific peregrine hybrid developed at Cornell. This hybrid was successfully introduced in eastern U.S. to replace the original, but now extinct subspecies (F. peregrinus anatum). The same lack of coverage applies to the endangered Red wolf of southeastern U.S. because so many individuals have been found to have coyote genes. Once again, the philosophical question of what constitutes a species still seeks resolution.

Hybridization will continue in natural populations, although most hybrids are no more successful than most mutants are. Thus heliconius hybrids have a different wing color pattern than either of their parents. Predators that avoid the parents by recognizing their wing patterns are more likely to eat a hybrid, despite its bad taste, because they have not yet had time to associate the novel wing pattern with the hybrid's taste. Hybrids are thus more vulnerable than their parent species, and this may account in part for their limited number. Nonetheless, occasionally a hybrid, like a mutant, will appear to fill a heretofore unfilled biological niche and survive as many plants have done.

Hybrids thus serve to transmit genetic information between gene pools, but natural selection eventually determines whether a new and novel combination of genes survives. Even new genetic combinations that give resistance to specific insect pests, although initially useful to the wild hybrids that have them, may in the long run be subject to unanticipated natural checks that keep them from spreading. These "leaking genes" that are spread by hybridization can create ethical dilemmas, as in the case of the spreading North American Ruddy duck population in Europe. It escaped from collections, particularly in England, and crossed with the endangered

White-headed duck, a close relative. To save the native duck, authorities in England proposed shooting all Ruddy ducks, but strong opposition from animal rights groups blocked the effort.

What is the proper course for maintaining species? There is no answer because species are hard to define and they are not static, nor can some be identified as "good" and others as "bad." The best we can hope to do is to dampen the spread of exotic species and to delay the demise of native ones so that they can proliferate and survive. Our ability to control the destiny of endangered species is limited; in the long run, it will be the forces of nature that determine which species survive and which do not. But if the past is any predictor of the future, we can expect 99% of the species existing today to become extinct and be replaced by those more adaptable to our planet's changing environmental conditions. In terms of human life spans, this change is far into the future, but nonetheless something we ought to contemplate.

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