The Garden of Our Neglect:
How Humans Shape the Evolution of Other Species

As humans have come to dominate the planet, they have modified not only their own evolutionary course but also that of fellow species. Although such alterations help us survive, their unintended evolutionary consequences often produce harmful results that threaten our well-being

- By Rob Dunn on July 5, 2012 – (edited for educational purposes 2016)

For the vast majority of the history of our kind we were in some ways no more sophisticated than crows, which use sticks to poke around in promising holes. Eventually, of course, we discovered fire and invented stone tools, which then led to guns, pesticides and antibiotics. Using these tools, we encouraged the survival of favorable species such as wheat and yeast needed for beer and cows for meat and milk. We even developed new species that are beneficial to the agriculture industry through crossbreeding and engineering. But we also encouraged a garden of neglect—a surprising number of resilient pests that have been able to survive in spite of our weapons. These species are now coming back to haunt us as toxins, pathogens or worse. Here are ten ways we have affected species around us.

1. SHARP ROCKS, SOFT FLESH. In the beginning someone held aloft a sharpened rock. "Progress!" he screamed out, or maybe, "Ouch!" depending on which end he grabbed. With that first stone weapon and its many pointy descendants, life changed. Our initial impact would have been small. However, by 10,000 years ago we had extinguished many of the largest species on Earth easily killed with weapons and tools – Sea Cows, American Cheetahs, Black Rhino, Pyrenean Ibex (wild goat), Quagga (zebra-like grazer), Passenger Pigeon, Caribbean Monk Seal, Sea Mink, Tasmanian Tiger, Great Auk, Bubal Antelope and many more. In our wake, we left behind smaller species more able to reproduce rapidly or escape detection in the first place.

As humans came to rely on tools to survive, those with hands better able to make and wield those tools were more likely to pass their genes to the next generation. Hand bones of humans are quite different from those of other primates because of our use of tools. Our hands are better able to manage the subtle grips necessary for making and using tools to maim or kill other species. In response to our first tools the animals around us changed and so did we.

2. BIG FISH, LITTLE FISH. Not only have we altered the course of big game evolution on land but we've also effectively reduced the size of fishes in the sea. Fishermen prefer to catch big fishes, and fishing regulations tend to prohibit the harvest of the smallest individuals of a species. In response, fishes have evolved the ability to reproduce at a smaller size and/or younger age. If they can breed before they get big enough to be harvested their genes stand a much higher chance of being passed on. American plaice, Atlantic cod, Atlantic herring, Atlantic salmon, brook trout, and chinook salmon all have appeared to grow more slowly and/or to reproduce at smaller sizes where and when they are heavily fished. Once, a large cod could eat a small boy. Now, a small boy could almost eat an entire cod.

3. RESISTANCE IS FUTILE. Bacteria have been evolving in response to threats from other species, including fungi, for hundreds of millions of years. Bacteria and fungi compete for food and often do so using chemical warfare. A fungus evolves an antibiotic and bacteria evolve resistance, so fungi evolve a new antibiotic. Recently, though, things changed. We invented (or rather stole from fungi) antibiotics, which allowed us to kill bacteria—and, importantly, treat bacterial infections. However, by using them too much, too incompletely or too indiscriminately we cause bacterial strains resistant to our drugs to evolve. Unlike fungi, we cannot retaliate by simply evolving new antibiotics. Hundreds of bacterial lineages have evolved resistance to more than a dozen of our antibiotics. In response, we are forced to discover new antibiotics, an endeavor that has proved ever more difficult.

4. GOING (ANTI)-VIRAL. Viruses generally evolve even more quickly than bacteria. For example, multiple drugs for HIV infection are taken together as a cocktail for one reason: the HIV virus evolves quickly. The cocktail slows the evolution of full resistance. Even if HIV evolves resistance to one drug, the odds it will evolve complete resistance to all three are far lower. Similarly, the flu that usually starts each year in Asia is different by the time it reaches North America. The flu virus evolves to get by not only as a function of how we respond to it (the drugs we make to rid ourselves of it) but also in response to our population size and patterns of movement. It, and other viruses, even evolve within our bodies. The virus that makes you sick is almost inevitably different than the one you give someone else.

5. PESTICIDES. In wild grasslands up to one third of the living mass of plants is eaten by herbivores. In our crop fields just 10 percent is eaten. The difference is in part the result of the more than 2.3 billion kilograms of pesticides we use annually to control pests. Though in holding back the pests, we also kill many beneficial species and favor varieties resistant to our pesticides. Resistance to pesticides has evolved in hundreds of species of insects. In addition to pesticides for insects, farmers also use fungicides to kill fungi. Nearly all fungicides have led to the evolution of new resistant strains of plant pathogens (Gould).

6. HERBICIDES. Any patch of land, left alone, will tend to sprout with plants bent on outcompeting each other, rising higher and higher into the sky to win access to the sun. Once, we prevented such competition by weeding our fields and sorting crop seeds from weed seeds, one by one. This selection depended on visual acuity and caused multiple lineages of weeds to evolve seeds resembling those of our crops. Now we exclude weeds using herbicides, whether in our lawns or our fields, before they bear their seeds. The weeds evolve resistance to herbicides, becoming invisible to our chemicals rather than our eyes. More than a hundred species of weeds have evolved resistance to one or another herbicide. We clear the ground, till the soil and spray the fertilizer and herbicide, and when we do, row by row the resistant weeds grow.

7. ENVIRONMENTAL TOXINS. The environmental toxins we produce are everywhere. Often they influence the health and well-being of species around us; sometimes they also influence their evolution. PCBs (aka polychlorinated biphenyls) were once used in industrial coolants. Whereas PCBs are good coolants, they are toxic. PCBs kill fish and other animals, in part by blocking one of the receptors in their bodies, AHR2. The fish with ordinary receptors simply died where PCBs were plentiful, leaving behind food and habitat. Those fish with slightly different receptors, to which the PCBs bound less well, survived and eventually thrived. PCBs were never meant to be used to control other species. Nevertheless, they had the effect of killing some (but not all) of the species and individuals they came into contact with, strongly favoring the individuals with resistance of one form or another. Nor are PCBs unique. Many of our pollutants—be they heavy metals, cadmium, oil and others—appear to lead to rapid evolution of tolerant and, at least sometimes, toxic creatures.

8. OF MICE (AND RATS) AND MEN. Mice and rats have been following humans since at least the origins of agriculture more than 10,000 years ago. It is easy to imagine we have probably been trying to kill them for nearly as long. More recently, however, we've been poisoning these pests, offering them tempting treats laced with deadly chemicals. Rats living in forests and other wild places are attracted to new foods in particular and so feed readily from such baits. Rats living with humans are not, at least not anymore. Present them with a new food and they will wait. Several authors have suggested that this "neophobia" (fear of anything new) in urban rats has evolved in response to the threat posed to rats and mice by our new "foods." For now, the little we know about the evolution of neophobia fits with this idea. The clearest evolutionary change in rats and mice as a result of our interference has been the evolution of resistance to the rat poison, *warfarin*. We then created *superwarfarin* to target these resistant populations, but resistance to this poison has recently evolved.

9. URBAN JUNGLE. Plant species living in urban environments tend to be surrounded by patches of habitat less suitable than the ones in which they are situated. Seeds that disperse far from their mothers are more likely to end up in those less suitable surroundings (think: concrete or pavement). As a consequence some city plants have evolved to produce fewer, larger seeds that fall near them rather than smaller ones that can disperse farther away. Although this type of quick evolution lends a short-term survival advantage, it may mean that these plants are less robust to adapt to a changing environment in the future. Meanwhile, thousands of other city species are acquiring new survival mechanisms despite the ways we build our cities, whether that means evolving the ability to eat concrete, call more loudly to their mates or simply find a place among our towers of glass and steel to hide.

10. THE NEW GALÁPAGOS. Our stone weapons and antibiotics are just a few of the tools we've created that have inadvertently helped shape the evolution of the species around us. Simply moving around has caused changes, too, many of which may be innocuous but all of which are unintentional. We have moved cane toads, wild pigs, mice, rats, weeds, sparrows, pavement ants and thousands of other species around the world with us. These species have responded to our tools, but they have also responded to the climate and organisms already present in the places we have introduced them. A recent study in Australia found most of the hundreds of plant species introduced there show some evidence of recent evolution, post-introduction to the new environment, with many of them apparently having evolved smaller, more drought-tolerant forms. Cane toads introduced to Australia are evolving longer legs that aid in colonizing new habitats. Where cane toads are present snakes are evolving smaller mouths (those with bigger mouths eat cane toads and, in doing so, die). Vultures introduced to the Canary Islands have evolved larger bodies. Elsewhere, house sparrows, cane toads, houseflies and many other species show evidence of evolving differently in different places. Each new place to which we introduce organisms is a kind of island and the species, new versions of Darwin's Galápagos birds.

Ultimately, whereas evolution can be whimsical (think: vampire bats), its general tendencies are predictable. It revisits its best-worn routes. If we continue to manage the world around us as we have managed it in the past, it's likely we'll continue to favor even more of those species that thrive despite us, species that are resistant to our drugs, pesticides and toxins. Such species might get bigger or more beautiful, but probably not. And, a world filled with small, resistant species is not necessarily what we want. It's time to use our knowledge of evolution and its well-worn paths to cultivate a new garden as we plan our future, one seeded with species that benefit rather than harm us.

Name:____

How Humans Shape the Evolution of Other Species

The article "How Humans Shape the Evolution of Other Species" by Rob Dunn explains 10 ways that humans have affected evolution. Whether it was intentional or not, these actions affected species around us. READ the entire article, then pick 4 of the 10 and briefly explain a) what role humans played, b) the "change" that resulted in the species and c) the effect this change in the species had on its surroundings or its future.

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