GlobalResearch
Center for Research on Globalization

“The Sixth Extinction”: Biological Annihilation. Vertebrates, Insects and Plants

A Planet in Loss Mode

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Theme: Environment
Global Research, December 12, 2018
TomDispatch 11 December 2018

*If you’ve been paying attention to what’s happening to the nonhuman life forms with which we share this planet, you’ve likely heard the term “the Sixth Extinction.” If not, look it up. After all, a superb environmental reporter, **Elizabeth Kolbert**, has already gotten a Pulitzer Prize for writing a book with that title.*

Whether the sixth mass species extinction of Earth’s history is already (or not quite yet) underway may still be debatable, but it’s clear enough that something’s going on, something that may prove even more devastating than a mass of species extinctions: the full-scale winnowing of vast populations of the planet’s invertebrates, vertebrates, and plants. Think of it, to introduce an even broader term, as a wave of “biological annihilation” that includes possible species extinctions on a mass scale, but also massive species die-offs and various kinds of massacres.

Someday, such a planetary winnowing may prove to be the most tragic of all the grim stories of human history now playing out on this planet, even if to date it’s gotten far less attention than the dangers of climate change. In the end, it may prove more difficult to mitigate than global warming. Decarbonizing the global economy, however hard, won’t be harder or more improbable than the kind of wholesale restructuring of modern life and institutions that would prevent species annihilation from continuing.

With that in mind, come along with me on a topsy-turvy journey through the animal and plant kingdoms to learn a bit more about the most consequential global challenge of our time.

Insects Are Vanishing

When most of us think of animals that should be saved from annihilation, near the top of any list are likely to be the stars of the animal world: tigers and polar bears, orcas and orangutans, elephants and rhinos, and other similarly charismatic creatures.

Few express similar concern or are likely to be willing to offer financial support to “save” insects. The few that are in our visible space and cause us nuisance, we regularly swat, squash, crush, or take out en masse with *Roundup*.

As it happens, though, of the nearly two million known species on this planet about 70% of them are insects. And many of them are as foundational to the food chain for land animals as plankton are for marine life. Harvard entomologist (and ant specialist) E.O. Wilson once

observed that “if insects were to vanish, the environment would collapse into chaos.”

In fact, insects are vanishing.

Almost exactly a year ago, the first long-term study of the decline of insect populations was reported, sparking concern (though only in professional circles) about a possible “ecological Armageddon.” Based on data collected by dozens of amateur entomologists in 63 nature reserves across Germany, a team of scientists concluded that the flying insect population had dropped by a staggering 76% over a 27-year period. At the same time, other studies began to highlight dramatic plunges across Europe in the populations of individual species of bugs, bees, and moths.

What could be contributing to such a collapse? It certainly is human-caused, but the factors involved are many and hard to sort out, including habitat degradation and loss, the use of pesticides in farming, industrial agriculture, pollution, climate change, and even, insidiously enough, “light pollution that leads nocturnal insects astray and interrupts their mating.”

This past October, yet more troubling news arrived.

When American entomologist **Bradford Lister** first visited El Yunque National Forest in Puerto Rico in 1976, little did he know that a long-term study he was about to embark on would, 40 years later, reveal a “hyperalarming” new reality. In those decades, populations of arthropods, including insects and creepy crawlies like spiders and centipedes, had plunged by an almost unimaginable 98% in El Yunque, the only tropical rainforest within the U.S. National Forest System. Unsurprisingly, insectivores (populations of animals that feed on insects), including birds, lizards, and toads, had experienced similarly dramatic plunges, with some species vanishing entirely from that rainforest. And all of that happened before Hurricane Maria battered El Yunque in the fall of 2017.

What had caused such devastation? After eliminating habitat degradation or loss — after all, it was a protected national forest — and pesticide use (which, in Puerto Rico, had fallen by more than 80% since 1969), Lister and his Mexican colleague Andres Garcia came to believe that climate change was the culprit, in part because the average maximum temperature in that rainforest has increased by four degrees Fahrenheit over those same four decades.

Even though both scientific studies and anecdotal stories about what might be thought of as a kind of insectocide have, at this point, come only from Europe and North America, many entomologists are convinced that the collapse of insect populations is a worldwide phenomenon.

As extreme weather events — fires, floods, hurricanes — begin to occur more frequently globally, “connecting the dots” across the planet has become a staple of climate-change communication to “help the public understand how individual events are part of a larger trend.”

Now, such thinking has to be transferred to the world of the living so, as in the case of plummeting insect populations and the creatures that feed on them, biological annihilation sinks in. At the same time, what’s driving such death spirals in any given place — from pesticides to climate change to habitat loss — may differ, making biological annihilation an even more complex phenomenon than climate change.

The Edge of the Sea

The animal kingdom is composed of two groups: invertebrates, or animals without backbones, and vertebrates, which have them. Insects are invertebrates, as are starfish, anemones, corals, jellyfish, crabs, lobsters, and many more species. In fact, invertebrates make up 97% of the known animal kingdom.

In 1955, environmentalist Rachel Carson's book *The Edge of the Sea* was published, bringing attention for the first time to the extraordinary diversity and density of the invertebrate life that occupies the intertidal zone. Even now, more than half a century later, you've probably never considered that environment — which might be thought of as the edge of the sea (or actually the ocean) — as a forest. And neither did I, not until I read nature writer Tim McNulty's book *Olympic National Park: A Natural History* some years ago. As he pointed out: "The plant associations of the low tide zone are commonly arranged in multistoried communities, not unlike the layers of an old-growth forest." And in that old-growth forest, the starfish (or sea star) rules as the top predator of the nearshore.

In 2013, a starfish die-off — from a "sea-star wasting disease" caused by a virus — was first observed in Washington's Olympic National Park, though it was hardly confined to that nature preserve. By the end of 2014, as Lynda Mapes reported in the *Seattle Times*, "more than 20 species of starfish from Alaska to Mexico" had been devastated. At the time, I was living on the Olympic Peninsula and so started writing about and, as a photographer, documenting that die-off (a painful experience after having read Carson's exuberant account of that beautiful creature).

The following summer, though, something magical happened. I suddenly saw baby starfish everywhere. Their abundance sparked hope among park employees I spoke with that, if they survived, most of the species would bounce back. Unfortunately, that did not happen.

> "While younger sea stars took longer to show symptoms, once they did, they died right away," Mapes reported.

That die-off was so widespread along the Pacific coast (in many sites, more than 99% of them) that scientists considered it "unprecedented in geographic scale."

The cause? Consider it the starfish version of a one-two punch: the climate-change-induced warming of the Pacific Ocean put stress on the animals while it made the virus that attacked them more virulent. Think of it as a perfect storm for unleashing such a die-off.

It will take years to figure out the true scope of the aftermath, since starfish occupy the top of the food chain at the edge of the ocean and their disappearance will undoubtedly have cascading impacts, not unlike the vanishing of the insects that form the base of the food chain on land.

Concurrent with the disappearance of the starfish, another "unprecedented" die-off was happening at the edge of the same waters, along the Pacific coast of the U.S. and Canada. It seemed to be "one of the largest mass die-offs of seabirds ever recorded," Craig Welch wrote in *National Geographic* in 2015. And many more have been dying ever since, including Cassin's auklets, thick-billed murres, common murres, fork-tailed petrels, short-tailed shearwaters, black-legged kittiwakes, and northern fulmars. That tragedy is still ongoing and its nature is caught in the title of a September article in *Audubon* magazine:

> “In Alaska, Starving Seabirds and Empty Colonies Signal a Broken Ecosystem.”

To fully understand all of this, the dots will again have to be connected across places and species, as well as over time, but the great starfish die-off is an indication that biological annihilation is now an essential part of life at the edge of the sea.

The Annihilation of Vertebrates

The remaining 3% of the kingdom Animalia is made up of vertebrates. The 62,839 known vertebrate species include fish, amphibians, reptiles, birds, and mammals.

The term “biological annihilation” was introduced in 2017 in a seminal paper by scientists **Geraldo Ceballos, Paul Ehrlich**, and **Rodolpho Dirzo,** whose research focused on the population declines, as well as extinctions, of vertebrate species.

> “Our data,” they wrote then, “indicate that beyond global species extinctions Earth is experiencing a huge episode of population declines and extirpations.”

If anything, the 148-page *Living Planet Report* published this October by the World Wildlife Fund International and the Zoological Society of London only intensified the sense of urgency in their paper. As a comprehensive survey of the health of our planet and the impact of human activity on other species, its key message was grim indeed: between 1970 and 2014, it found, monitored populations of vertebrates had declined in abundance by an average of 60% globally, with particularly pronounced losses in the tropics and in freshwater systems. South and Central America suffered a dramatic loss of 89% of such vertebrates, while freshwater populations of vertebrates declined by a lesser but still staggering 83% worldwide. The results were based on 16,704 populations of 4,005 vertebrate species, which meant that the study was not claiming a comprehensive census of all vertebrate populations. It should instead be treated as a barometer of trends in monitored populations of them.

What could be driving such an annihilatory wave to almost unimaginable levels? The report states that the main causes are “overexploitation of species, agriculture, and land conversion — all driven by runaway human consumption.” It does, however, acknowledge that climate change, too, is a “growing threat.”

When it comes to North America, the report shows that the decline is *only* 23%. Not so bad, right? Such a statistic could mislead the public into thinking that the U.S. and Canada are in little trouble and yet, in reality, insects and other animals, as well as plants, are dying across North America in surprisingly large numbers.

From My Doorstep to the World Across Time

My own involvement with biological annihilation started at my doorstep. In March 2006, a couple of days after moving into a rented house in northern New Mexico, I found a dead male house finch, a small songbird, on the porch. It had smashed into one of the building’s large glass windows and died. At the same time, I began to note startling numbers of dead piñon, New Mexico’s state tree, everywhere in the area. Finding that dead bird and noting those dead trees sparked a desire in me to know what was happening in this new landscape of mine.

When you think of an old-growth forest — and here I don't mean the underwater version of one but the real thing — what comes to your mind? Certainly not the desert southwest, right? The trees here don't even grow tall enough for that. An 800-year-old piñon may reach a height of 24 feet, not the 240-feet of a giant Sitka spruce of similar age in the Pacific Northwest. In the last decade, however, scientists have begun to see the piñon-juniper woodlands here as exactly that.

I first learned this from a book, *Ancient Piñon-Juniper Woodlands: A Natural History of Mesa Verde Country*. It turns out that this low-canopy, sparsely vegetated woodland ecosystem supports an incredible diversity of wildlife. In fact, as a state, New Mexico has among the greatest diversity of species in the country. It's second in diversity of native mammals, third in birds, and fourth in overall biodiversity. Take birds. Trailing only California and Arizona, the state harbors 544 species, nearly half of the 1,114 species in the U.S. And consider this not praise for my adopted home, but a preface to a tragedy.

Before I could even develop a full appreciation of the piñon-juniper woodland, I came to realize that most of the mature piñon in northern New Mexico had already died. Between 2001 and 2005, a tiny bark beetle known by the name of *Ips confusus* had killed more than 50 million of them, about 90% of the mature ones in northern New Mexico. This happened thanks to a combination of severe drought and rapid warming, which stressed the trees, while providing a superb environment for beetle populations to explode.

Image on the right: Dead finch on my porch. Photo by Subhankar Banerjee, 2006.

And this, it turned out, wasn't in any way an isolated event. Multiple species of bark beetles were by then ravaging forests across the North American West. The black spruce, the white spruce, the ponderosa pine, the lodgepole pine, the whitebark pine, and the piñon were all dying.

In fact, trees are dying all over the world. In 2010, scientists from a number of countries published a study in *Forest Ecology and Management* that highlights global climate-change-induced forest mortality with data recorded since 1970. In countries ranging from Argentina and Australia to Switzerland and Zimbabwe, Canada and China to South Korea and Sri Lanka, the damage to trees has been significant.

In 2010, trying to absorb the larger ecological loss, I wrote:

> "Hundreds of millions of trees have recently died and many more hundreds of millions will soon be dying. Now think of all the other lives, including birds and animals, that depended on those trees. What happened to them and how do we talk about that which we can't see and will never know?"

In fact, in New Mexico, we are finally beginning to find out something about the size and nature of that larger loss.

Earlier this year, Los Alamos National Laboratory ornithologist Jeanne Fair and her colleagues released the results of a 10-year bird study on the Pajarito Plateau of New Mexico's Jemez Mountains, where some of the worst piñon die-offs have occurred. The study shows that, between 2003 and 2013, the diversity of birds declined by 45% and bird

populations, on average, decreased by a staggering 73%. Consider the irony of that on a plateau whose Spanish name, *Pajarito*, means "little bird."

The piñon die-off that led to the die-off of birds is an example of connecting the dots across species and over time in one place. It's also an example of what writer Rob Nixon calls "slow violence." That "slowness" (even if it's speedy indeed on the grand calendar of biological time) and the need to grasp the annihilatory dangers in our world will mean staying engaged way beyond any normal set of news cycles. It will involve what I think of as long environmentalism.

Let's return, then, to that dead finch on my porch. A study published in 2014 pointed out that as many as 988 million birds die each year in the U.S. by crashing into glass windows. Even worse, domestic and feral cats kill up to 2.4 billion birds and 12.3 billion small mammals annually in this country. In Australia and Canada, two other places where such feline slaughters of birds have been studied, the estimated numbers are 365 million and 200 million respectively — another case of connecting the dots across places and species when it comes to the various forms of biological annihilation underway on this planet.

Image below: Dead piñon where birds gather in autumn, northern New Mexico. Photo by Subhankar Banerjee, 2009.

Those avian massacres, one the result of modern architecture and our desire to see the outside from the inside, the other stemming from our urge for non-human companionship, indicate that climate change is but one cause of a planet-wide trend toward biological annihilation. And this is hardly a contemporary story. It has a long history, including for instance the mass killing of Arctic whales in the seventeenth century, which generated so much wealth that it helped make the Netherlands into one of the richest nations of that time. In other words, Arctic whaling proved to be an enabler of the Golden Age of the Dutch Republic, the era when Rembrandt and Vermeer made paintings still appreciated today.

The large-scale massacre and near extinction of the American bison (or buffalo) in the nineteenth century, to offer a more modern example, paved the way for white settler colonial expansion into the American West, while destroying Native American food security and a way of life. As a U.S. Army colonel put it then,

> "Kill every buffalo you can! Every buffalo dead is an Indian gone."

Today, such examples have not only multiplied drastically but are increasingly woven into human life and life on this planet in ways we still hardly notice. These, in turn, are being exacerbated by climate change, the human-induced warming of the world. To mitigate the crisis, to save life itself, would require not merely the replacement of carbon-dirty fossil fuels with renewable forms of energy, but a genuine reevaluation of modern life and its institutions. In other words, to save the starfish, the piñon, the birds, and the insects, and us in the process, has become the most challenging and significant ethical obligation of our increasingly precarious time.

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