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Reviews

Anthropocene Mass extinction

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Elizabeth Kolbert's new book, *The Sixth Extinction* is an Unnatural History, is a useful, well written, and accessible work. It is, however, a distressing read for those concerned with the impact of the human population on the ecology of the planet. This is because it sets out in stark terms the crisis of global biodiversity that has developed since the industrial revolution in particular, and how it continues to get worse at an alarming rate today.

She argues that from global warming alone (and there are myriad other factors involved), if it reaches its expected maximum by the middle of this century (and it could be worse than that), between 38 and 52 per cent of species "would be fated to disappear". She argues that an extinction rate of this scale ultimately puts at risk all species on the planet, including, eventually, our own.

To put this in perspective she takes looks at 450 million years of geological history and reviews the five previous mass extinctions that are recognized to have taken place since complex animals emerged. (A mass extinction is generally recognised as an event involving a profound loss of biodiversity in a geologically insignificant amount of time.)

From this she concludes that we are now witnessing the sixth great extinction. And we are not just witnessing it, she reminds us, we are participants in it, and it's about time we took the issue seriously.

She defines the previous mass extinction events as follows The End Ordovician Extinction, 450m years ago, the Late Devonian Extinction, 370m years ago. The End Permian Extinction, which was the most devastating and known as the mother of all extinctions, 225m years ago. The Late Triassic Extinction, 200m years ago, and the most recent, the End Cretaceous Extinction that took place around 60 m years ago that destroyed two thirds of all species at a stroke and saw the end of the dinosaurs.

The commonality of these previous extinctions, she argues, is that they were all the result of naturally occurring phenomena ranging from continental drift, glaciation, temperature change, chemical changes such as the acidification of the oceans, volcanic eruptions or earthquakes, or with the End Cretaceous the impact of a giant asteroid.

Today's sixth extinction, she contends, is very different. It is, as she suggests in the title of the book, an "unnatural" event. It has the magnitude of a mass extinction but this time it is not brought about by naturally occurring phenomena but as the direct result of the unwitting activity of one individual species on all the rest. This is the most intelligent, successful, and rapacious species the planet has produced "Homo sapiens, or modern human beings.

The term she uses for the current geological epoch therefore is the Anthropocene or an epoch defined by the impact of human activity on the ecology of the planet.

This was coined by the ecologist Eugene Stoermer and supported by the Nobel Prize-winning atmospheric chemist Paul Crutzen, who argues that the impact of human activity on the earth's ecology today is so significant as to constitute a new geological epoch. The term has not yet officially recognised by the scientific community, though Kolbert is confident that it will be.

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She argues that since modern humans emerged 200,000 years ago, with their ingenuity, intellect, hunting skills, and drive to explore they have always had a disproportionate impact on other species. They were responsible for the demise of many of the large mammals that had no other predators but were vulnerable to modern humans. They were also, she argues, responsible for the demise of the Neanderthals, who lacked some of their key attributes.

She explains, how, much more recently, as maritime capability developed and colonial expansion started, sailors chomped their way through isolated and vulnerable species such as the dodo, the great auk, the giant tortoise, and flighted birds that had evolved with no fear of predation. The large, but slow moving, Steller's sea cow was hunted to extinction. Such species went from abundance to extinction in very short periods of time.

It was not until the industrial revolution, however, and the arrival of capitalism of course (although that is not a factor that she draws attention to), that the full impact of modern humans was felt on the ecology and biodiversity of the planet with the massive use of fossil fuels in particular. To research all this Kolbert travelled the world to meet scientists on the front line who are studying this process and trying to find some answers.

She visited the rain forest of the Manu National Park in the high Peruvian Andes, one of the planet's biodiversity hot spots, to meet forest ecologist Miles Silman who was studying the effect of global warming by monitoring plants as they migrate up the mountain at rates of up to 100 feet a year in search of a higher, cooler, climate zone.

The conclusion Silman reaches is that global warming will not just affect biodiversity in the cold regions where the loss of ice, for example, is threatening those species that depend on it such as the polar bears and the ringed seal. It is also affecting, even more severely, the tropical regions where most species live.

She travelled to a 10 hectare reserve (reserve 1202) in Amazonia to look at the impact of tropical deforestation and habitat fragmentation on the biodiversity crisis. She found that Reserve 1202 is a part of a patchwork of such reserves (bits of rain forest) left behind for conservation purposes after the loggers had cleared the bulk of the forest. She met researchers who were studying how the plants and animals deal with such isolation and how much protection such reserves provide.

The conclusions she came to were that such fragments provide little protection and that a conservative figure is that something like 5,000 species are being lost each year or 14 species a day in the tropical regions.

She visited the El Valle Amphibian Conservation Centre (EVACC) in Panama, which is dedicated to the survival of endangered amphibians, and linked up with its director Edgardo Griffiths for a scary look at what is happening to the planet's amphibian population. She found that amphibians are not only the group of species that has managed to survive most successfully everything that the planet has thrown at them for hundreds of million years but they are now amongst the most endangered group of species particularly over the past 40 years when their plight has become catastrophic.

Amphibians, she points out, are affected not only by habitat loss and general pollution but the spread of diseases and invasive species resulting from the globalization of travel and the mass transportation of goods that now reaches every corner of the planet. All this produces a figure that is hard to grasp: that the extinction rate among amphibians could be a mind-boggling 45,000 times (yes 45,000) higher than the background rate i.e. the rate that existed for millions of years before the current die off began.

The background rate of extinction varies with different species of course. With mammals this has been calculated to be about one every 700 years yet in the current event a quarter of all mammal species are at risk over just few

hundred years.

She went to Castello Aragonese, a tiny island about thirty kilometers west of Naples in order to meet scientists studying the acidification of the oceans and to see under water carbon dioxide vents that render the sea around the island to a level of acidity that is already the fate of some parts of the oceans and could be the fate of the whole ocean if fossil fuels continue to be used at current rates.

She describes a scene where the organisms that rely on calcification for their shells or body structure are in big trouble. Barnacles are bleached white and the shells of the mussels, snails, and sea urchins are being dissolved by acidification. Small crustaceans have all but disappeared.

She points out that since the start of the industrial revolution humans have added some 365 billion metric tons of carbon into the atmosphere. Deforestation has added another nine billion tons. Each year this increases by another nine billion tons. This has increased the carbon in the atmosphere to over 400 parts per million and rising. This not only generates the warming of the atmosphere but since carbon dissolves readily into water it enters the oceans and creates acidification. Global warming is therefore a double whammy. Today, she observes, the oceans are absorbing around two and a half billion tons of additional carbon a year.

The oceans are already 30 times more acidic than they were in 1800 and at the current rate by the end of the century they will be 150 times more acidic than at the start of the industrial revolution. Here, she observes, there is a link to the past since ocean acidification played an important part in at least two of the previous two mass extinctions "at a time when all life was confined to the oceans.

She visited the tiny One Tree Island on the Great Barrier Reef to meet scientists from the University of Queensland who were studying the health of the coral reefs "and to witness the annual coral spawning. She discovered that the threat to coral reefs does not just come from acidification but also from overfishing, which promotes algae growth, deforestation and the resulting loss of water clarity, and dynamite fishing but most importantly from global warming.

Tropical reefs need warm seas but their temperature range is very narrow. Excessive heat disrupts their reproduction process and causes a condition called bleaching. She points out that there have been three major bleaching events in recent years "1998, 2005, and 2010" and that the frequency and intensity of such events are expected to increase as the global temperature climbs ".

She looks at the mass die-off of millions of bats in the Northeast of the USA as a result of a fungus transported around the world as a result of modern travel and trade. She looks at the imminent extinction of large and iconic species such as Suci the Sumatran rhino in Cincinnati Zoo, a member of a species on the very edge of extinction, who can't ovulate unless she senses there is a male around who is ready to mate. And since the nearest male is 10,000 miles away Suci has a serious reproductive problem.

She looks at the problem of introduced and invasive species and concludes (remarkably) that in any 24 hour period 10,000 different species are being moved around the world just in ballast water. She looks at the example of Hawaii where a new invasive species is added every month. In terms of species distribution she concludes that we are moving towards a situation where the world will be just one big continent.

There is an abundance of additional examples Elizabeth Kolbert could give to make her case. As I was writing this review there was news that barn owl numbers in Britain have reached a dangerous new low. But she has done more than enough, in my view, to make her case that we are living through the epoch of the Anthropocene.

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She doesn't offer any quick solutions or urge us to step up our campaigning activities in defence of the environment and of endangered species"although this is implicit in what she says, the people she meets, and how she presents them.

The book is an appeal for a greater awareness of what is going on. She urges us to think more deeply about our own role in the process: "If you want to think about why humans are so dangerous to other species, you can have a picture of a poacher in Africa carrying a AK-47 or a logger in the Amazon gripping an axe, or better still, you can picture yourself, holding a book on your lap."

She also poses an important question. In an extinction event of our own making, she asks, what will happen to us? Her answer runs as follows: "Having freed ourselves from the constraints of evolution, humans nevertheless remain dependent on the earth's biological and geochemical systems. By disrupting these systems"cutting down tropical rain forests, altering the composition of the atmosphere, acidifying the oceans"we're putting our own survival in danger! When a mass extinction occurs, it takes out the weak, but it also lays low the strong."

The advantage we have, she argues, is that whilst the damage done by modern humans was for most of the time unwitting it is no longer unwitting. We have the ability to take a new course, should we choose to do so, and its about time we discussed it seriously.

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