When Mother Nature gets cross

The danger to man's polluted and despoiled oceans is real, according to a new book by a Dutch-born paleoclimatologist Judy Siegel-Itzkovich reports

Man had better stop recklessly regarding the Earth's vast oceans as the world's garbage dump. Although the waters that cover more than 70% of the planet seem limitless, they are in fact dangerously polluted and in danger of sinking humanity if we don't quickly clean up our act.

The physical and chemical damage caused in the past century or two to the 4.4 billion-year-old oceans have been much greater than harm that has been caused over eons by natural processes to the waters themselves and the creatures that live in them, says Prof. Eelco Rohling, a renowned paleoceanographer and paleoclimatologist at the Australian National University and the University of Southhampton's National Oceanography Center. In an incredibly detailed 262-page hardcover volume titled *The Oceans: A Deep History*, Rohling shakes up every reader who bothers to dive into the massive amount of worrisome information.

Paleoceanography is the study of the ancient oceans and ancient climates as they changed and developed together over geologic time and involves analyzing data like layers of sediment taken from the seabed.

Published by Princeton University Press, the $25 book will raise concerns among scientists in many fields and the general public and should even shock and upset someone like US President Donald Trump, who minimizes the influence of man on climatic changes such as global warming.

While some have written that we know more about the moon, where man landed in 1969, than about the oceans, this is not really true, as Rohling's volume shows the profundity of his understanding of complex processes that have affected the oceans, as well as salty seas and sweet-water lakes over millions of years.

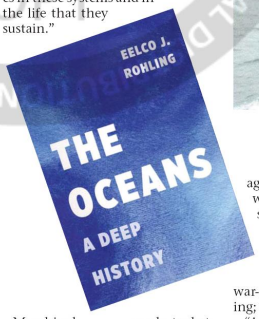
ROHLING RECEIVED his bachelor's of science degree in general geology, with a minor in microfossils, in 1984, followed by a master's of science degree in micropaleontology, physical oceanography, climatology and sedimentology in the three years later 1987 and his doctorate (whose thesis brought all the fields together) in 1991 – all from Utrecht University in the Netherlands. The expert in ocean and climate change is a fellow of the American Geophysical Union, a working-abroad fellow of the Royal Netherlands Academy of Arts and Science, and dividing his time between Australia and England, he has many more prestigious honors in his field.

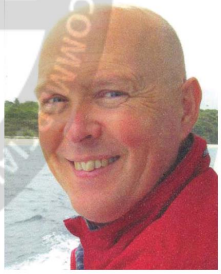
In fact, he actually dreamed of being a brain surgeon when he was a boy.

"But I did not pass the lottery to get into medical school when I went to university. So I thought about what else to study for a year before trying again. I ended up doing geology, and never looked back," he said in an interview. "I pushed on with that instead of trying medical school again. In geology, I developed a fascination with the past environments in which animals and plants lived that we now find as fossils. My interest in past ocean and climate change became much deeper and more specific."

While he is one of the most prominent in the field, Rohling writes that there are well over 1,000 researchers currently active in this field around the world.

He decided to write this volume because he and his editor "felt that the vast existing knowledge about the past oceans – and past climate – needed to be better articulated and placed in context of modern changes in these systems and in the life that they sustain."





PROF. EELCO ROHLING
(Courtesy)

Mankind needs to better understand the oceans, he continued, because they hold "many fascinating pieces of information about how the ocean/climate system works and how it interacts with life and the planet itself. No other field can bring that information to the table. The oceans' history also holds important clues about how Earth may recover from human impact, and on what time scales such a recovery may be expected."

The history of the oceans reflect on their future, because it "illustrates the key processes by which carbon-cycle changes have occurred over Earth history and what the time scales were for these changes. It also illustrates which processes we might try to accelerate to drive atmospheric carbon-removal on time scales useful to humankind. Moreover, the history of the oceans provides insight into the developments and extinction of life on Earth, which again gives context about the severity and rapidity of current changes."

Changes caused by humanity "are unique with respect to the rates of change: Modern changes are 10 to 100 times faster than the fastest-ever natural changes any time before humans appeared on the scene. And, also, human-made changes have significant impacts from many different sides: warming, ocean acidification, physical (e.g., plastic) pollution, chemical pollution, eutrophication [excessive nutrients that seep into bodies of water, frequently due to runoff from the land, which causes a dense growth of plant life and death of animal life from lack of oxygen, overfishing and more]. Natural changes were not that all-encompassing. So modern changes are very scary in relation to the natural changes that have occurred, even when including major extinction events."

Mankind takes the oceans for granted, said Rohling. People have trouble imagining how their (often little) actions can add up over time, and across the massive population numbers. But we're on this planet with well over seven billion people, all of whom at least partly rely on the ocean as a key resource. We damage it by such things as dumping waste; pollution from plastics; ship wreckages; netting; salt from desalination plants; oil spills; radioactive materials; chemical waste and fertilizers; food production/fisheries; war-mongering; exploration/mining; energy production and more.

"Added up over our massive human population and increasing technical infrastructure, all of these aspects alone have devastating impacts already, but taken together they are heading down a particularly terminal route."

One doesn't have to look at the Pacific, Atlantic, Indian, Antarctic and Arctic Oceans to see the damage. The harm done to the North American Great Lakes and to our own Mediterranean Sea shows up very clearly, declared Rohling.

The Great Lakes were born of a massive climate change at the end of the last Ice Age some 21,000 years ago.

"The Earth's orbit shifted, climate warmed, and the vast ice sheet that covered North America melted. A tremendous volume of melt-water flowed across the landscape, filled basins left by the receding ice, and created vast swampy marshes and wetlands around the lakes. When settlers migrated along the southern shore of Lake Erie... thick mud and standing water surrounded clumps of giant Sycamore and Bur Oak trees. To the settlers, the trees blocked the light, while the standing water bred mosquitoes (which we now know carried malaria) and hid the farmland they needed to survive. So, the Great Black Swamp was drained, and some of the most fertile farmland in the US arose."

But draining the Great Black Swamp profoundly impacted Lake Erie, as the muddy body of water was a natural filter that removed nutrients from its slow-moving streams before they could enter the lake. Cities expanded, and raw sewage was dumped into waterways, providing still more nutrients. The agricultural revolution that occurred following WWII added cheap commercial fertilizers to the mix, amplifying the problem. By the 1960s and 1970s, eutrophication fueled enormous blooms of cyanobacteria in the warm, shallow waters of Lake Erie's western basin. Winds and currents drove them eastward, into the Central Basin and Cleveland's suburban and urban sprawl. As the blooms died and sank, microbial decomposition released nutrients and consumed oxygen. It also made bottom waters more acidic, which caused a release of more nutrients back into the water from the sediments. This contributed to even larger blooms in subsequent years, he noted.

By the 1990s, the lake smelled like rotten eggs. The US Environmental Protection Agency was established and the Clean Water Act was passed by Congress, leading to massive efforts to remove phosphorus from soaps and detergents. Fetid water was sent to waste-treatment plants, and factory smokestacks had to be augmented with pollution-scrubbing equipment. All this led to improvements in the quality of the waters of Lake Erie. But according to Rohling, this improvement retreated due to agricultural and suburban runoff, and the lake's nutrient levels pushed back up to values not seen since the 1970s.

The Dutch-born author noted that the late American president John F. Kennedy not only launched a plan to send man to the moon but in his 1961 address to Congress called for a major increase in ocean research. Sea expeditions are very expensive, as at least eight weeks are needed to arrive and return from a site where only three weeks of actual exploration and testing occurs. A single research trip can cost over $1 million.

OUR DEAR Mediterranean is in no better shape than Lake Erie.

"Around 8,000 years ago, the entire eastern half of the Mediterranean Sea became severely oxygen-starved between 300 and 1,500 meters and lost all oxygen, or became 'anoxic,' below that. It wasn't warming that caused the oxygen decline then, as is happening in today's oceans, but the amplification of the African monsoon, which drove intense flooding of the Nile River, full of nutrients from decomposing organic matter. The freshwater itself inhibited deep-water formation, while its nutrient-load led to wild-growth of algae, cyanobacteria and animals grazing on them. Upon their death, decomposition sapped oxygen from the water, rapidly turning it oxygen-starved."

Today, the Mediterranean's water quality has been harmed severely by pollution from oil spills, sewage and from plastic bags and other junk that has broken down into microscopic sizes and harm fish and smaller living things.

Coral reefs such as those in the Eilat region that we rave about are in danger around the world due to heat-stress-related coral bleaching. A sharp rise in ocean acidification will further aggravate the situation, said Rohling. This used to take place once every 30 years or so, but today, the process has shortened to only about six years, giving the corals little time to recover. The death of coral reefs is unfortunate not only due to the loss of their beauty and variety but since they house about a third of all the oceans' biodiversity, it will affect much more.

The author urges governments, parliaments and the citizenry in general to stop arguing if there is global warming but instead to take immediate steps to reduce atmospheric pollution by strictly controlling carbon emissions and cutting acidification.

(TNS)

"We must make a very rapid transition toward a zero-carbon-emissions society, and that we urgently need to develop ways of removing excess, already emitted, carbon from the coupled atmosphere-ocean system." An added bonus, he noted, is that these measures will also reduce pollution of the air we breathe and water we drink, improve public health, boost research and development into new technologies and increase new business opportunities.

As his book combines facts that sound an alarm to the world along with more than 120 pages of detailed and difficult historical and scientific material almost indigestible for nonprofessionals, he might have been wiser to write two volumes – one for the layman, including government leaders, and another for scientists and other specialists who swim more easily in all the technical details.

Yet Rohling's message is of great importance. In the epilogue, he notes, "Mother Nature's patience seems to be up. There are clear warning signals of an impending... mass extinction. It may even have started already. Common sense suggests a prudent response of large-scale action toward a responsible, sustainable future, and it is clear that we're going to have to step up and help nature with removing the carbon."

All the signs are that the time of healthy oceans "is running out fast. Earth's history shows us clear examples of what happens when Mother Nature gets really cross... We would be wise not to play dare with her against such stakes."

Bacterial immune systems take the stage

NEW WORLDS

• By JUDY SIEGEL-ITZKOVICH

Until a decade ago, scientists were not aware that bacteria had complex immune systems that could keep up with the pace of evolution in viruses called phages that infect bacteria. That changed with the discovery of what is now the most famous bacterial immune mechanism: CRISPR. This is a natural gene editor

have "anti-CRISPR" proteins that cancel CRISPR activity,

sequences from hundreds of different bacteria, the team turned to synthetic biology: getting the genes made to order. They sent the strings of gene code – totaling something like 400,000 bases, or "letters" of genetic code – to a commercial lab where dozens of different multi-gene systems were synthesized for testing.

LIGHTNING LESS LIKELY IN A WARMING PLANET

Lightning may strike less often in the future across the globe as the planet warms, a scientific study from the Universities of Edinburgh, Leeds and Lancaster suggests. The research, published in *Nature Climate Change*, forecasts a 15% drop in the average number of

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that has revolutionized the world of biological research in thousands of labs around the world. Researchers now understand that most microorganisms have sophisticated immune systems of which CRISPR is just one element; but there has been no good way to identify these systems.

In a massive, systematic study, Prof. Rotem Sorek and his team at the Weizmann Institute of Science in Rehovot have now revealed the existence of 10 previously unknown immune defense mechanisms in bacteria.

"The systems we discovered are unlike anything we had seen before," said Sorek. "But among them, we think there are one or two that might have the potential to increase the gene-editing toolbox and others that point to the origins of the human immune system." The results of their study were recently published in the journal *Science*.

Bacteria cannot rely on CRISPR alone in the war against phages, explained Sorek, a member of the institute's molecular genetics department. Indeed many phages suggesting that other systems take up the slack.

Sorek and his team began their search for these systems by creating a computer program to scan all the bacterial genomes that have ever been sequenced – around 50,000 genomes in all.

Rather than look for sequences with predefined characteristics, the algorithms they created searched for the "statistical signatures" of genes involved in defense – for example, their location in "defense islands" where several defense-related genes are found near one another. Then, because immune system genes rarely work alone – even in bacteria – the researchers developed complex computer analytic methods so as to understand which genes join forces and work together to form a defense system.

Once they had narrowed down the possible defense genes from millions to several hundred, the researchers needed to test the candidate mechanisms they had identified. Rather than attempting to isolate the genetic

These synthetic systems were inserted into lab bacteria whose natural immune systems were inactivated. The bacteria were then exposed to phages and other infective elements to see if the transplanted defense system was a viable one. Out of the various systems the researchers examined, 10 strongly protected the lab bacteria from infection, thus identifying them as new immune defense systems. The researchers still don't know how the new bacterial immune systems function.

"The fact that we managed to find 10 new bacterial defense systems implies there are even more out there," concluded Sorek.

"The new discoveries are exciting because of the new windows they provide on the evolution of immune systems and the eternal battle between viruses and the organisms they infect. Any one of the new systems we found might be the next gene-editing tool – or perhaps even the foundation of even more exciting molecular tools."

lightning flashes worldwide by the turn of this century if global temperatures turn out to be in the top range of forecasts.

A drop in the incidence of lightning strikes could impact on the frequency of wildfires, especially in tropical regions. It could also lower the incidence of lightning strikes to infrastructure and affect how greenhouse gases in the atmosphere contribute to climate change.

The team found a new way to calculate the likely incidence of lightning flashes from storm clouds. Unlike traditional calculations of lightning flashes at the global scale, which are based on the height of clouds, their approach takes into account the movement of tiny ice particles that form and move within clouds. Electrical charges build up in these ice particles, and in cold water droplets and soft hail formed inside clouds. These are discharged during storms, giving rise to lightning flashes and thunder. Scientists estimate there are 1.4 billion lightning flashes each year around the world.