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Waves of disaster

By Roberta Staley
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They are called lantern fish, silvery navigators of the ocean's deepest depths, bug-eyed, blunt-nosed, and gap-mouthed, with close-set rows of pointy teeth.

Every night around the globe, at least 600 million tonnes of these finned creatures, along with a few related species—which make up as much as 90 percent of deep-sea fish biomass—swim upward from their dark hiding places to near the ocean's surface to gorge on zooplankton, made up of organisms that are often too tiny to be seen with the naked eye, such as the shrimplike krill, jellyfish, and arrow worms.

As they forage, the lantern fish, up to 15 centimetres in length when mature, are snapped up by larger marine creatures: seals and whales, squid, and commercial fish like yellowfin tuna, swordfish, mahi-mahi, sharks, and salmon. A handful of commercial fisheries around the world also catch this small delicacy to sell to consumers in Asia and Eastern Europe.

Just a simple fish tale? Unfortunately, no. Rather, it is a tale of environmental and human-health disaster in the making, as the lantern fish's bounteous numbers give it an importance in the global food chain that far outweighs its diminutive size and prosaic appearance.

For the past half-century, the ocean has been a dumping ground for human detritus, most notably plastic. Nonbiodegradable, plastic doesn't readily decay and can last upward of 1,000 years. It is made of molecules, called monomers, that are created from petroleum. Linked together to make plastic, monomers become polymers.

When plastic is discarded in the ocean, these polymer chains start to break apart, creating a floating confetti on the surface. These minute red, blue, and clear pills are mistaken by lantern fish for zooplankton, says Charles Moore, founder of the Long Beach, California–based Algalita Marine Research Foundation, a private ocean-research organization that is affiliated with the University of California at Irvine and the University of the Pacific in Stockton. In some areas of the ocean, plastic outnumbers surface zooplankton six to one, Moore says.

This is more than unappetizing—it's poison. Plastic is oil-soluble, and it both absorbs and releases poisons: PCBs, or polychlorinated biphenyls, a persistent environmental pollutant; dioxin, a known human carcinogen; and gasoline and other petroleum-based products. These substances end up in the ocean through illegal biochemical- and garbage-dumping (despite international conventions against polluting), oil spills, and sewage and street runoff.

Lantern fish have no "genetic ability to differentiate between zooplankton and plastic", Moore says. "We have been screwing up the ocean with

plastic for 50 to 60 years. The fact that we've done it so fast and that it has penetrated so low into the food chain is alarming, but we're just beginning to make a scientific assessment of what this means."

This year, the Algalita laboratory conducted necropsies on 600 lantern fish caught in the Pacific Ocean. More than half of these fish had plastic fragments inside their gastrointestinal tract. One Algalita technician found 84 pieces of plastic in the stomach of a 6.3-centimetre lantern fish. Moore says these findings are "statistically significant".

Not only are these fish being poisoned, they are not putting on fat stores needed for reproduction, says Moore, whose findings on plastic consumption by lantern fish will be published this fall in the prestigious scientific journal Environmental Research.

Plastic has usurped the wise simplicity embedded within the evolutionary food chain, in which each link nourishes the one above. Plastic bits are consumed by lantern fish, which are consumed by larger fish like tuna that, in turn, end up in tin cans in the kitchen cupboard.

Human infants, arguably the pinnacle of the food chain, ingest environmental chemicals through breast-feeding—contaminants glom on to the proteins and fats in breast milk. (It has been known for many years that Canada's Inuit, who eat fatty seal, fish, and whale, have PCBs and mercury in their blood and breast milk at levels that scientists believe may adversely affect fetuses and breast-fed infants.)

Already, humans are exposed to an estimated 29,000 chemicals present in the environment through cosmetic additives, flame retardants, gasoline byproducts, pesticides, paint thinner, and dry-cleaning products, to name but a few. Now, it appears, we are also ingesting our chemicals—as an entrée.

Are humans staring down the tunnel at an ineluctable future, a Socratic death by a modern-day hemlock? "This issue is so important and so relevant and so underreported," Moore says.

How did plastic come to rend the natural cycle of the ocean, the womb of Earth whence all life, from plants to insects to humans, sprang, perhaps four billion years ago? And what are the implications for humans as our oceans are churned into a soup of chemical and plastic?

Frederick vom Saal, professor of biological sciences at the University of Missouri at Columbia, is a world-recognized expert on the effects of plastic-related chemicals on fetal development, growth, and sexuality. Creatures like the lantern fish are, vom Saal says, the "canary in the coal mine. People should be concerned about the degradation of the aquatic system, because if it goes, life as we know it is going to go."

Some of the chemicals used to make plastic cause an array of problems in laboratory animals, including metabolic upset, obesity, lowered sperm count, prostate tumours, accelerated sexual maturity, breast tumours, and miscarriages, vom Saal says.

These findings can be extrapolated to all species, he says, because cellular mechanisms are virtually identical in "mouse, fish, rat, or human. The mechanisms developed over hundreds of millions of years of evolution and are extremely similar across all vertebrates. If they can be harmed, so can we."

Two chemicals are especially worrisome to vom Saal. One is bisphenol A, or BPA, first synthesized 117 years ago. It is the building block of polycarbonate, found in many plastics and epoxy resins.

It is also in pesticides, flame retardants, coatings for metal cans, returnable beverage containers, baby bottles, plastic food containers, recycled paper, eyeglasses, the coating on paper receipts, dental fillings, sports helmets, and plastic eating utensils. It also happens to be, vom Saal says, an environmental estrogen—an endocrine disruptor mimicking a natural sex hormone produced in human ovaries, called estradiol, one of three naturally occurring estrogens.

The price of pollution. Tisma photo.

The other is a group of chemicals known as phthalates, which make vinyl and other plastics flexible. This chemical has been shown to block the ability of testes to produce testosterone, vom Saal says.

The National Institute of Environmental Health Sciences, which is funded by the United States Congress, stated in an April draft report on BPA that it has “negligible concern that exposure of pregnant women to bisphenol A will result in fetal or neonatal mortality, birth defects, or reduced birth weight and growth in their offspring”. As well, chemical side effects have occurred in lab animals “at exposure levels far in excess of those experienced by humans”.

Vom Saal says that these statements are a deliberate effort to confuse the public. Adult humans metabolize and excrete BPA. However, most people, vom Saal says, maintain levels of BPA in the blood of two to four parts per billion, depending upon their age.

The natural hormone estradiol is found at a blood level of one part per trillion. This makes BPA “staggeringly potent”, vom Saal says. “This is 1,000 times higher than the ability of the cells to respond to this chemical. There is, clearly, no safe amount.”

Vom Saal has spent his career studying embryo development, the hormonal mechanisms that create sexual differentiation, and the effect of

endocrine disruptors on this complex process.

“There is concern,” he notes, that endocrine disruptors may upset the precise, delicate process of fetal development, leading to problems such as gender-identity disorder, or the feeling of being trapped in a body of the wrong sex. To date, there is a lack of systematic study analyzing links between gender-identity disorder and environmental chemicals. However, “you don’t have to have a PhD or be a physician to know that estrogenizing males and blocking testosterone is going to wreak havoc,” vom Saal says.

Studies dating back almost two decades point to subtle changes in human physiology, likely due to environmental influences. In 1992, Danish scientists reported that sperm counts were decreasing by one percent a year. By the late 1990s, research showed that sperm counts were dropping by 1.5 percent a year in the U.S. and three percent a year in Europe and Australia.

Finally, in 2005, a nonpartisan alliance of scientists and organizations called the Collaborative on Health and the Environment presented findings in Menlo Park, California, on changes in male human infants. Those babies that had high exposure to phthalates showed a shortened distance between the anus and genitals, similar to a girl’s. Other trends identified were cryptorchidism, or undescended testicles, and hypospadias, when the urethral opening is located on the penile shaft instead of on the tip.

Vom Saal applauds the Canadian government, which, he says, showed leadership this year in conducting a complete risk assessment of BPA with the objective of initiating possible bans. Ottawa invited public commentary on BPA during a 60-day period that wrapped up in June, and Health Canada plans to present a risk-management approach this fall.

Despite warnings—it has been known since the 1930s that BPA is an endocrine disruptor—nothing has been done to initiate a comprehensive recycling program with the ultimate objective of achieving zero garbage output, Moore says. “The ocean really needs us to embody a zero-waste culture on land,” Moore says. “That’s the only way she is going to heal herself.”

Moore, famously, discovered the Great Pacific Garbage Patch while sailing in 1997. The vast cemetery of human detritus is captured in a slow-spinning gyre that starts just above the equator and stretches 50 degrees of latitude north, in line with Vancouver.

A briny Brobdingnagian mass of bobbing fishing line and nets, computers, bags, shampoo caps, toothbrushes, tires, bottles, diapers, tampon tubes, and plastic containers, the Garbage Patch is estimated to be at least 620,000 square kilometres—about 20 times the size of Vancouver Island—and 30 metres deep. Fed by currents carrying garbage originating in North America and eastern Asia—80 percent of it from land, with the rest from ships and oil rigs—this plastic colossus is growing like a slow cancer, Moore says.

Algalita researchers, who have trolled the Garbage Patch seven times in the past decade, have just finished analyzing water samples and found double the number and double the weight of plastic fragments found in a comparable 1999 study, Moore says.

Not only is this poisoning marine creatures, but they are becoming entangled in the garbage and rogue nets. Peter Ross, a Sidney, B.C.–based marine-mammal toxicologist with Fisheries and Oceans Canada’s Institute of Ocean Sciences, says an estimated 100,000 marine animals a year die entangled or caught in nets. As well, the UN Environment Programme notes that plastic debris every year kills more than a million seabirds, which mistake the rubbish for food.

Perhaps the most worrisome victims of the garbage are the gentle giants of the ocean, the leatherback turtles, which have lived in the seas for 70 million years, since the time of dinosaurs. Regular summer visitors to the jellyfish-rich waters south of Vancouver Island, leatherback turtles, which can reach 600 kilograms, have undergone a population decline of 90 percent in only 20 years, according to Scott Benson, an ocean ecologist with the National Oceanic and Atmospheric Administration's Southwest Fisheries Science Center in Moss Landing, California. Not only do these turtles become trapped in nets, they also die from ingesting plastic bags that they mistake for jellyfish, the chief component of their diet.

It is obvious that a huge international effort, which includes rigorous garbage disposal and recycling as well as the banning and control of chemicals, is needed to restore the health of the oceans and, ultimately, human health. One step in this direction, says University of British Columbia fisheries economist Rashid Sumaila, is the creation of long-term sustainable fisheries, which will require most of the world's fishermen to hang up their nets.

This year, blockades and work stoppages by fishermen protesting soaring fuel prices caused the European Union to create an emergency fund worth $3.2 billion in subsidies. Sumaila says this money could be better spent retraining fishermen and helping them move into other sectors, thus reducing the pressure on stocks of fish like wild salmon, whose numbers are in alarming decline.

Moreover, the ingestion of seafood is not necessary to maintain optimum human health, despite current media hype extolling the benefit of omega-3 fatty acids, says David Jenkins, a professor in the faculty of medicine at the University of Toronto. Jenkins, who is internationally renowned for his research on nutrition and chronic disease, says that medical evidence regarding the benefits of seafood is ambiguous at best. Thus, the need to preserve current fish stocks far outweighs continued ocean trawling to feed public demand, Jenkins says.

Scientists generally concur that about 65 million years ago, a meteor slammed into Earth near what is now the Yucatán Peninsula in Mexico, contributing to the mass extinction of the dinosaurs and other organisms. Some scientists view humanity's degradation of the environment as ultimately as destructive as the meteor.

It is ironic that creatures such as the critically endangered leatherback turtle survived the meteor but may not survive humans. In light of our impact on the environment, will humans be able to survive humans?
