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THE FOOD ISSUE

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SEAFOOD UNDER THREAT

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LETTER FROM THE EDITOR

Dear Readers,

Have you ever heard the phrase, "you are what you eat?" Have you ever thought about what goes into the food you consume everyday, or the journey it takes to get to your plate?

In the first NUSci issue of the 2014-2015 academic year, we explore this very concept. From the ethics of the beef industry, to how corn is taking over the food we eat, to the labeling of genetically modified organisms, our writers invite you to learn about what you consume every day.

As always, the topics we cover are as diverse as our writers' interests. In addition to exploring what we put into our bodies, we explore what goes on in our minds and beyond. One of our writers reflects on her co-op experience working in a health center in Peru. We continue to cover the latest research on how our planet is changing due to global climate change, and the implications that rediscovering new species has on the ever-changing field that is taxonomy. We also discuss out-of-this-world news about possible life in the vacuum of space and how you could someday find yourself on a trip to the International Space Station.

The release of Issue 21 also marks a new chapter in the evolution of NUSci. This semester, we were lucky enough to recruit a plethora of new writers and designers, all of whom bring their enthusiasm, unique writing styles, and novel ideas to the magazine and website. Issue 21 bears a brand-new logo created by one of our talented new designers. We have debuted a new website with amazing exclusive features, and are working to continue expanding NUSci's potential to accurately report and distribute our finished product.

Revamping our magazine has not been an easy process. We would be nowhere without our returning writers, staff writers, designers, and editors, and can't thank you all enough for your continued dedication, effort, and patience. We are also so thankful for all of the hard work done by new members, and can't wait to see what more they can do in the future.

We hope you will enjoy the Food Issue of NUSci, and that, as always, it leaves you hungry for more.

Best wishes,

Katie Hudson

Marine Biology, 2017

Co-editor in Chief

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LESSONS LEARNED FROM MY INTERNATIONAL CO-OP

KATE BARRAL, HEALTH SCIENCES, 2015

I couldn't imagine feeling more out of place ... Everyone is staring at me... What am I doing here ... I don't know anybody ... What do I do now?

These are real thoughts and feelings from my international co-op in Cusco, Peru. While they were by no means how I felt throughout my entire co-op experience, they were a reality that I faced upon deciding to go to another country on my own for an extended amount of time, with no prior ties.

This won't be your average co-op story, full of happy anecdotes of splendid memories, but there are no awful ones either, just experiences. I learned so much about people, culture, communication, community, befriending complete strangers, and patience. As a student of science, I know there is a positive to every negative and a push to every pull, and with my experience, there was good as well as bad. I cleaned the head wound of a man attacked and robbed by an illegal cab driver, was stuck on a bus for two days in the middle of the Peruvian countryside, and was held up at knifepoint. However, I also danced at a wedding ceremony with the relatives of my host family, was fed by humble villagers when hungry, and watched approximately 30 live births, by far the coolest and happiest moment.

My volunteer work was at Belempampa Centro de Salud (Center of Health). This volunteer program was not well structured, plain and simple. There was no real accountability for the volunteers at the center. The director of the clinic was technically the supervisor for the volunteers. However as a physician with many patients and the general tasks of operating a busy clinic, he didn't have time to monitor and instruct foreign volunteers, the local medical school students, and the nursing school students. It was up to the volunteers to be accountable and take control of our work. I was first placed in the Emergency Room, or "Quick Care," as the center was not an actual hospital

with an operating room. While there I gave a lot of intramuscular antibiotic injections as well as cleaned wounds, most of which were dog bites from the many stray dogs around Cusco. After Quick Care, I transitioned to the tuberculosis department, where I worked with patients getting tested for TB and patients receiving treatment for TB. I collected samples and brought them to the lab to be tested on a daily basis, and learned about medication regimens. I then moved to Child and Infant Health, where I observed and assisted in the vaccination programs of infants and young children. This might sound impressive, but the most amount of work I got to do in one day in was fold 500 pamphlets for mothers to track their child's vaccinations.

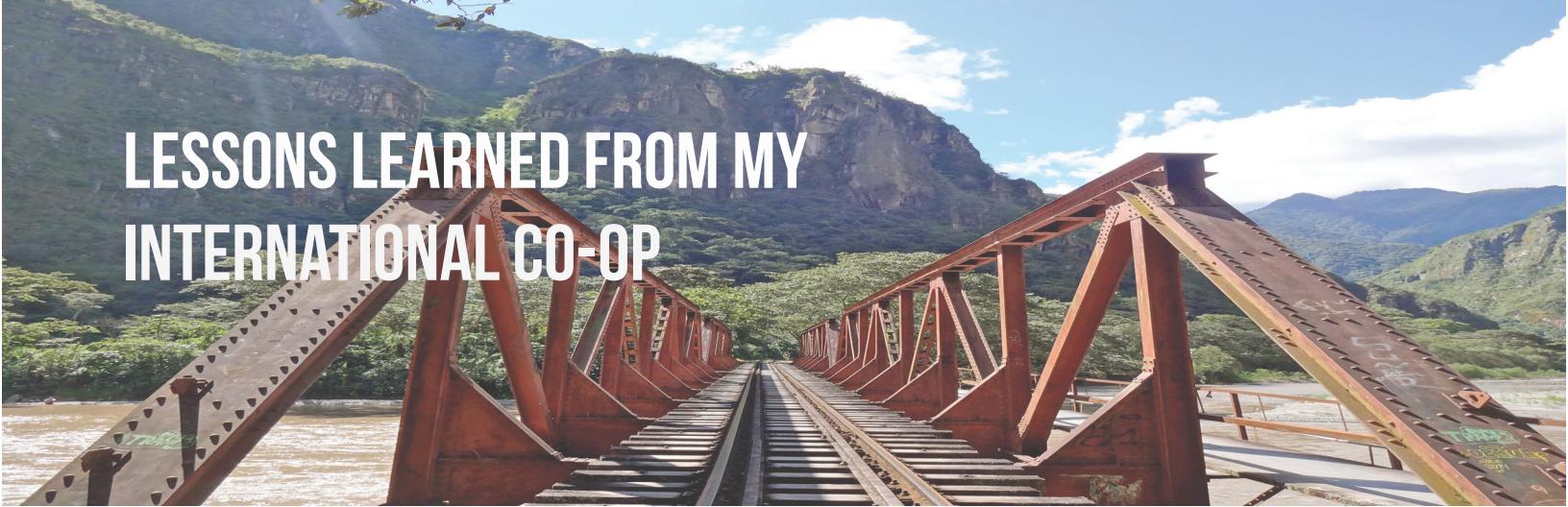
I learned along with the other volunteers that if you wanted to perform a task and gain valuable experience, you had to speak up. As foreign interns, we were behind in the pecking order after the local nursing and medical school students. I asked to be transferred to "Sala de Partos," the delivery room, where I spent one month observing babies being born. I had the responsibility of dressing the baby after it had been cleaned off and its measurements had been recorded, and I often had the chance to carry the newborn to the mother after she was transferred to a recovery room. Some days there were no births; on one particularly remarkable day, eight births occurred. I also witnessed the center's one thousandth birth, for which the lucky and surprised mother received baskets of congratulatory gifts.

I spent my last month back in Quick Care, due to the fact I felt most utilized there. It was there that I became well skilled at administering intramuscular injections and cleaning wounds. During the time it took me to clean the wound of the man who was attacked by a taxi driver, he told me that my Spanish was very good. It was then that I realized that I had been talking to the patient in Spanish during the whole encounter. It was an enlightening moment and one that I didn't think would happen easily.

A lot of my other experiences came when traveling around Peru on the weekends. It was while traveling with newly accumulated friends that we found ourselves stuck on a bus due to a strike, where the locals set up numerous and primitive roadblocks so no traffic would pass for miles in either direction, in an effort for an increase in wages for those working on the construction of a new airport nearby. It was also while traveling that we experienced the third largest festival in South America, the festival of the Virgen de Candelaria, the patron saint in the city of Puno in Peru. The festival lasted for about four days, with groups of people from nearby towns and communities around Lake Titicaca celebrating by dancing, drinking, and playing music in choreographed parades all throughout the town. Ultimately and unforgettably, my favorite trip that I went on outside of work was to Machu Picchu, a town built into the Andes Mountains by the native Peruvian people, which was left untouched for hundreds of years until its discovery in 1911, and which is now one of the seven wonders of the modern world. While my work in Peru was the most important aspect for me to learn from, I had so many opportunities to travel and experience the culture around me, that I can't help but feel I got to experience the best of both worlds.

I returned home to the U.S. on May 22nd, 2014, almost five months after I had departed. Although I wanted to stay longer, I could no longer afford the cost of the program and host accommodations. I treasured the time I spent in Peru and know someday I will return, whether for pleasure or for more work. If interested in going abroad for work, in whatever field, I encourage you to reach out to those, familiar or unfamiliar, who have done the exact program in the location you are interested in participating. Don't assume anything; ask questions, lots of them. And above all, leave all your expectations at home. ■

Photo courtesy of Kate Barral



SHOULD GMOS BE LABELED?

GWEN SCHANKER, BIOLOGY AND JOURNALISM, 2018

Whether organisms should be genetically modified has been a subject of debate since the 1970s, when scientists Stanley Cohen and Herbert Boyer created the first recombinant DNA organism and transgenic plants emerged as the newest breakthrough in biotechnology. Genetic modification of crops allows for greater yields at a lesser cost, and can also reduce the crop's impact on the environment. Genetically Modified Organisms (GMOs) also contain potential nutritional benefits, which could provide better food quality for the developing world. However, opponents fear undetermined long-term health effects of consuming GMOs, an overall decrease in biodiversity, and a negative impact on surrounding non-GMO crops.

Many experts don't have a black-and-white opinion on GMOs. Martin Dagoberto, the cofounder and organizer for Massachusetts Right to Know GMOs, a network of advocates for GMO labeling, has a background in biotechnology and thus understands the uncertainties associated with genetic modification.

"In the course of my studies, I gained an appreciation for the magnitude of risks we're taking with genetic engineering," said Dagoberto, who graduated from Worcester Polytechnic University in 2006 before switching his focus to environmental and social justice organization.

Despite controversy over the impact of genetically modified foods – on the environment, consumers, and the organisms themselves – GMO production has increased over the years. Today, the amount of genetically engineered soybeans and crops grown in the United States is estimated to be more than ninety percent. The Food and Drug Administration, the American Medical Association and the World Health Organization, among others, have declared GMOs to be safe. However, there is concern that GMOs have not received proper testing, and the general public opinion is that genetically modified foods are a dangerous ambiguity. These conflicting ideas create a confusing framework for consumers.

A large part of the confusion is due to lack of information. Most genetically modified foods are not labeled, giving consumers doing their weekly grocery shopping little choice whether they buy genetically engineered products or not. The question of whether products should be labeled is an integral part of the GMO debate, and has been especially prominent recently. In May,

Vermont became the first state to require GMO labeling, excluding labeling for dairy products, pending the passage of a bill in January 2015. Some companies, like Ben and Jerry's and Target, are avoiding using genetically modified ingredients altogether until labeling laws have stabilized. On the other hand, others, like Whole Foods, have committed to complete transparency when it comes to consumer information.

believe that because consumers don't know enough about GMOs, they shouldn't receive any further information.

According to Dagoberto, most opponents of labeling are industries who rely on lack of public information to sell their products. "Part of their business model is keeping people in the dark," Dagoberto said. He added, "[Labeling] is a piece of factual information that is important to an increasing number of people."

Mandated labeling generally occurs only when there are potential health consequences involved (e.g. advisory labels that say "may contain nuts"). One of the arguments against labeling is that GMOs have so far been proven safe for consumption, and the economic and environmental benefits they provide make them an important part of today's grocery store shelves. Unnecessary fear-mongering might push GMOs off the market, causing scientists to take several strides backward from previous advances in biotechnology.

"MANY EXPERTS DON'T HAVE A BLACK-AND-WHITE OPINION ON GMOS"

That being said, consumers have a right to want to know more about what they're eating. For Dagoberto, the consumer's right to information takes precedence. "It just comes down to giving people a choice about what kind of food they're purchasing and what kind of agriculture they're supporting," he said.

Research shows that the public is in favor of labeling; a New York Times poll last July found that ninety three percent of Americans want GM foods to be labeled. The debates over whether GM products should be sold and over whether they should be labeled go hand in hand, but they pose two separate questions. Consumers should be aware that so far, there is no evidence that GMOs pose a risk to human health. However, consumers should also know the process of genetic modification and of which products contain GM ingredients. If labeling legislation is being pushed back because consumers don't have a proper understanding of the issue, the answer is not to keep people in the dark, but to tell them more of what they want to know – about GMOs, labeling and the future of biotechnology.



"More than half of the states are considering GMO labeling," Dagoberto said, citing the success in Vermont and conditional labeling laws passed in Maine and Connecticut. "Labeling initiatives have popped up across the country."

The basic argument for GMO labeling is that consumers have a right to know what goes into their food. Many labeling advocates don't argue against GMOs themselves, just in favor of receiving more information. However, critics of labeling are concerned that it will only exacerbate people's distrust in foods that are manipulated or processed in some way, and that it will create unnecessary fear of genetically modified products. In other words, opponents

THE BEES' NEEDS: COLONY COLLAPSE DISORDER AND ITS CAUSES

RACHEL STODDARD, BIOLOGY, 2017

There is no shortage of portrayal of bees in the media. Whether they take the form of an angry swarm chasing off Yogi Bear or a lovable mascot for breakfast cereal, bees have become part of pop culture and are one of the most easily recognizable figures of the insect family. The extent of our dependence on bees, however, is widely underappreciated. According to the United States Department of Agriculture's Agriculture Research Service (ARS), roughly a third of our diet is dependent on honeybees. As one of the most prolific pollinators, they represent a \$15 billion investment in the agriculture industry each year, and certain crops are completely dependent on the honeybee for survival.

Beginning in fall 2006, beekeepers began to notice significant drops in their hive populations. Some reported as much as a 90 percent decline in the hives. The strangest, however, was that these massive hive casualties did not yield any bodies. Large portions of the worker bee populations were simply gone, leaving behind healthy queens and immature bees.

Now known as Colony Collapse Disorder (CCD), this phenomenon is threatening agriculture as we know it. According to the ARS, since CCD was first observed, bee populations have continued to

present annual losses of roughly 30 percent per year. Beekeepers have managed to keep bee populations at critical levels for agriculture so far, but CCD has the potential to hugely impact the agriculture industry and drastically raise food prices if losses continue.

Scientists have been working furiously to find the root of the problem, with no major discoveries of any one "smoking gun." Scientists know that CCD is triggered by an aggregation of factors with monoculture, pesticides, parasites, and pathogens at the forefront. Understanding how these culprits combine could be the key to saving the bees.

historically bad reputation with environmentalists and conservationists. Several studies have shown that, though pesticides can be found in the vast majority of beehives across the country, they are not found in concentrations known to be lethal to honey bees. That is not to say that pesticides are blameless in this mystery; a 2012 study showed that sublethal levels of one pesticide in particular, imidacloprid, made honey bees more susceptible to the unicellular fungal parasite *Nesoma*. Other instances have been reported as well in which sub-lethal doses of pesticides seem to contribute to weakening immune systems and defense mechanisms of colonies.

**"THE STRANGEST, HOWEVER,
WAS THAT THESE MASSIVE
HIVE CASUALTIES DID NOT
YIELD ANY BODIES."**

Monoculture is a staple of current agricultural practices. Often, bees are brought in or raised to pollinate a single crop and, therefore, only ever have access to that specific species' pollen. Almonds are one example. According to the Almond Board of California, every year about 1.6 million colonies of honeybees must be shipped out to California to maintain the almond crop. During this time, bees almost exclusively come into contact with pollen from the almond trees. This can cause nutritional deficits, which have been linked with lowered immunocompetence levels.

Pesticides are also seen as a potential culprit of CCD, partly because of their

Varroa mites also pose a parasitic threat to bee colonies. In fact, parasites or viruses are consistently discovered in hives affected by CCD. Picorna-like viruses, a super-group of viruses consisting of six different families with single-stranded RNA structure, are found in most colonies that have experienced CCD. Of the Picorna-like viruses found in hives, acute bee paralysis virus, Kasmir bee virus, and Israeli acute paralysis virus are mentioned most often, though a myriad of others have also been discovered in colonies. Scientists are working on developing vaccines and medicines that could be given to the colonies to prevent and treat infections, but these must be invented on a case-by-case basis and will take a lot of time and funding to fully develop.

Despite extensive research, scientists remain unable to pinpoint at a specific cause of CCD. Jeffery Pettis, the research leader in the Bee Research division of the ARS, describes CCD as "a 1,000-piece jigsaw puzzle, and the best I can say is that a lot of pieces have been turned over. The problem is that they have almost all been blue-sky pieces—frame but no center picture." As research on this subject continues, a clearer picture of how to save the bees from this mysterious disorder will hopefully form. In the meantime, the ARS urges the public to limit pesticide usage and to plant pollinator-friendly plants whenever possible, ensuring that our cartoon friends' real-life counterparts remain safe and secure members of our agriculture system. ■





TITANOSAURS, GIGANTISM, AND THE REASON FOR BIG-BONED DINOSAURS

SHANNON JONES, MARINE BIOLOGY, 2016

Recently, there has been a spate of fossils discovered from unimaginably large dinosaurs. The largest yet discovered are the titanosaurian sauropods, a group of dinosaurs with huge bodies and necks but tiny heads, who lived in the southern hemisphere during the Cretaceous period. Think Little Foot's family, but bigger. Much bigger. Prior to this year, more than 30 different titanosaurian skeletons had been found in South America, and four in Africa – but these numbers have recently risen.

In South America this year, the partial skeletons of two massive dinosaurs called *Dreadnoughtus schrani* were discovered by paleontologists. This titanosaur is estimated to have been 85 feet long, with a skull and neck 40 feet long. One of the animals' fossilized remains was more complete than the other, with a whopping 70 percent of its bones fossilized. The surrounding rock gave a hint as to why these bones were so well preserved: the area seemed to have been a forest, with leafed and needled trees, and several major rivers. A flood in one of these rivers might have caused the rapid fossilization. Based on several of this dinosaur's body parts, it is estimated to have been roughly 65 tons at the time of its death. What's more, this titan's growth plates also showed it was still growing when it died.

Another, smaller titanosaur was also found in southeast Tanzania this summer. This creature has been dubbed *Rukwatitan bisepultus*, a thirty-foot long sauropod that had legs roughly seven feet long. While smaller than the *Dreadnoughtus*, it is still incredible that two new species were discovered in such a short time period, and with very complete skeletons.

Most sauropods usually only need to be identified by very few bones, because as a rule, larger organisms, such as the titanosaurians, are not well preserved. Scientists think that this may be due to their size. In order to fossilize, a bone has to be completely covered in sediment, creating an anoxic environment. With a larger size comes complications in this process; it is difficult for a large body, anywhere between 30 and 85 feet in these cases, to be covered completely in a short time period. Titanosaurs have been seen mostly in South America, but they lived in a time when Pangaea, a giant supercontinent that later split apart to form today's seven continents, was the

main landmass on the planet. For this reason, titanosaurs should be seen on South America, Africa, and Australia, but few have been found. As the discovering scientists of *Rukwatitan bisepultus* said in their paper, "Where titanosaurs represent the most diverse and cosmopolitan clade of Cretaceous sauropod dinosaurs, they remain rare components of Cretaceous African faunas." Northeastern Professor Justin Ries, a marine geologist, added, "Really, the amount of fossils we're finding is a statistical artifact. The larger something is, the less there are of them, and the conditions for something to be preserved that's that big have to be perfect. It has to basically fall into a swamp and be covered, otherwise it'll be dismembered and savaged and the fossils that do form will be broken and unrecognizable."

As we make discoveries like these, it's easy to wonder: what made the dinosaurs so huge? Why did they grow so big, when today the largest land animal is the African elephant, at 4 meters? Unfortunately, the answer is complex. There are multiple theories about how organisms can become large, all of which are in contention.

The oldest, and least supported, theory is that there used to be a higher oxygen content in the atmosphere, prior to the meteor impact that ended the age of the dinosaurs. While there was more oxygen in the air during the Carboniferous period, which is thought to have caused the gigantism in insects discovered from the time, there was an equal or smaller amount of oxygen while the majority of titanosaurs were seen.

A different theory, which has fallen out of favor with most scientists, is that the ancient Earth used to be much smaller, and had a proportionally smaller amount of gravity. This reduction of gravity was theorized to have removed the size restraints and allowed supermassive dinosaurs. This theory fails to explain how the Earth subsequently became larger. A spontaneous increase in size and gravity has never been seen and remains unproven.

A third explanation of the size of some dinosaurs is known as Cope's Rule. Cope was a scientist in the late 1800's, who theorized that as evolutionary time increases, size increases. His idea was that a larger size was optimal, and was therefore favored by natural selection. This

has since been thoroughly disproved in most organisms, as it is rare that gigantism is the fittest state of an organism.

"THINK LITTLE FOOT'S FAMILY, BUT BIGGER. MUCH BIGGER."

Today, the most prevalent theory is that dinosaurs were less constrained by size because of their relatedness to birds. If birds have bones that are light and thinly constructed, why not imagine that dinosaurs were built the same way? This theory was proposed historically, and has recently been supported by various fossil remains. In addition, fossils have shown that some dinosaurs had a complex air sac network throughout their necks and chests. These air sacs are seen in modern-day birds, and allow a higher level of breathing efficiency. Normally, a long neck means a long windpipe, which would usually lead to dead space and difficulties exhaling all of the air used in the last breath before inhaling again. This problem was eliminated with the use of air pockets in the neck, which could increase lung space exponentially.

In addition, the construction of a sauropod's head and neck was designed differently than modern animals. Without a heavy head and brain, a head could be much smaller. This size could have become even more reduced if sauropods gave up chewing at some point in their evolution, a change in behavior that is supported, but not confirmed, by the few sauropods neck fossils that have been found. Without needing to chew their greens, sauropods could consume more, with a more rapid intake and less energy used in processing.

Laying eggs was the final step on the route to gigantism in dinosaurs – by making development and birth processes that occur outside the body, more space was available to the dinosaur, as well as eliminating some of the energy costs that organisms incur by carrying young internally as they develop.

Though how some dinosaurs grew so large is in debate, we know that they inspire us. With the discovery of *Dreadnoughtus schrani* and *Rukwatitan bisepultus*, we have expanded our understanding of these supermassive giants of the past. Now, we just need to find Little Foot. ■

hyper connected

THE BRAIN POST DEPRESSION

NAOMI STAPLETON, PSYCHOLOGY, 2016

Neuroscientists could be on their way to accurately predicting risk for depression, thanks to a recent study. In their functional connectivity MRI (fcMRI) assessment, researchers at the University of Illinois at Chicago found hyper-connected emotional and cognitive networks in young adults with remitted depression.

It has already been established that significant brain differences exist between healthy and depressed brains. Research by Rachel Jacobs and her team at the University of Illinois' has yielded a better understanding of the origin of these differences, whether it be genotype-based factors or scars left by the illness itself.

Until now, it was not clear whether these differences are still observable when depression is in remission. Rachel Jacobs explained, "We wanted to see if the individuals who have had depression during their adolescence were different from their healthy peers." Focusing on individuals with remitted depression allowed for a broader view of the course of major depressive disorder (MDD) as well as the analysis of trait-based vulnerability without ongoing mental illness confounding the results.

The team assessed 18-23 year old healthy individuals as well as those with a history

of MDD. Significant differences in terms of "hyperconnectedness" existed in the young adults with remitted depression, suggesting that these differences are trait-markers of MDD susceptibility, rather than scars left by depression.

The team observed increased connectivity within and between the default mode network, salience networks, and the cognitive control network in the individuals with remitted depression. Jacobs explained the hyperconnectivity was these regions "talking to each other maybe a little too much," particularly in relation to rumination (also known as over-thinking) and sustained attention characteristics.

Lack of cognitive control over thinking processes is highly associated with the onset and relapse of depression. Rumination contributes to the attention and concentration difficulties typically observed in MDD. "Cognitive control and rumination, as you might expect, are related to each other. As rumination goes up, cognitive control goes down," said Scott Langenecker, a corresponding author of the study.

The team's next step is to longitudinally study the hyperconnectivities in these same participants as they transition into adulthood. This time period in which the brain's maturation

comes to a close could be a key window for intervention. According to Jacobs, teaching young adults how to move away from maladaptive cognitive strategies like rumination could prolong remission and prevent relapse.

"WE WANTED TO SEE IF THE INDIVIDUALS WHO HAVE HAD DEPRESSION DURING THEIR ADOLESCENCE WERE DIFFERENT FROM THEIR HEALTHY PEERS."

Even though therapy and medication can be helpful and contribute to remission of MDD, 50 percent of young adults with a history of depression will eventually relapse. The researchers hope that by studying the course of illness through fcMRI, treatment of teenage depression will become better informed and more accurately prescribed in the future. ■



THE RETURN OF THE ASTRONAUT

KATIE HUDSON, MARINE BIOLOGY, 2017

Three years ago, the last NASA space shuttle returned to planet Earth, marking the end of NASA's shuttle program. Since then, American astronauts have relied on other countries, primarily Russia, to get them off the planet and to the International Space Station. Since the end of the space shuttle program, NASA and the Obama administration have been keen to reboot it and have now made steps to reach that goal. On September 17th, 2014, NASA announced that it would be partnering with two private aerospace companies, Boeing and SpaceX, to work towards the return of the space shuttle program.

Neither Boeing nor SpaceX is new to the field of aerospace engineering. Boeing, known for its commercial airplanes, has been involved with NASA since the space race began in the 1960's. The company has built several rockets since then that have sent both people and satellites into space.

SpaceX, founded by Elon Musk, founder of Pay Pal and owner of Tesla, has been building rockets since 2002. Since their foundation, the company has built three rockets, including the Falcon 9, which has the ability to land itself on self-deployed metal legs after reentry, and the Dragon, which was the first commercial spacecraft to make a successful trip to the International Space Station in 2012.

The partnership between NASA and these two commercial aerospace companies come in the form of contracts with NASA that are part of the association's Commercial Crew Transportation Capability (CCtCap) program. Through these contracts, each company will build an integrated rocket and spacecraft system that will later be evaluated, tested, and certified by NASA to carry passengers and travel to the International Space Station.

Boeing's systems will be comprised of Boeing's CST-100 spaceship, to be launched on the Atlas V rockets of their own design in partnership with the United Launch Alliance, or on SpaceX's Falcon 9 launch vehicle. SpaceX will use their Falcon 9 launch vehicle and the Dragon spacecraft in their system. Earlier this

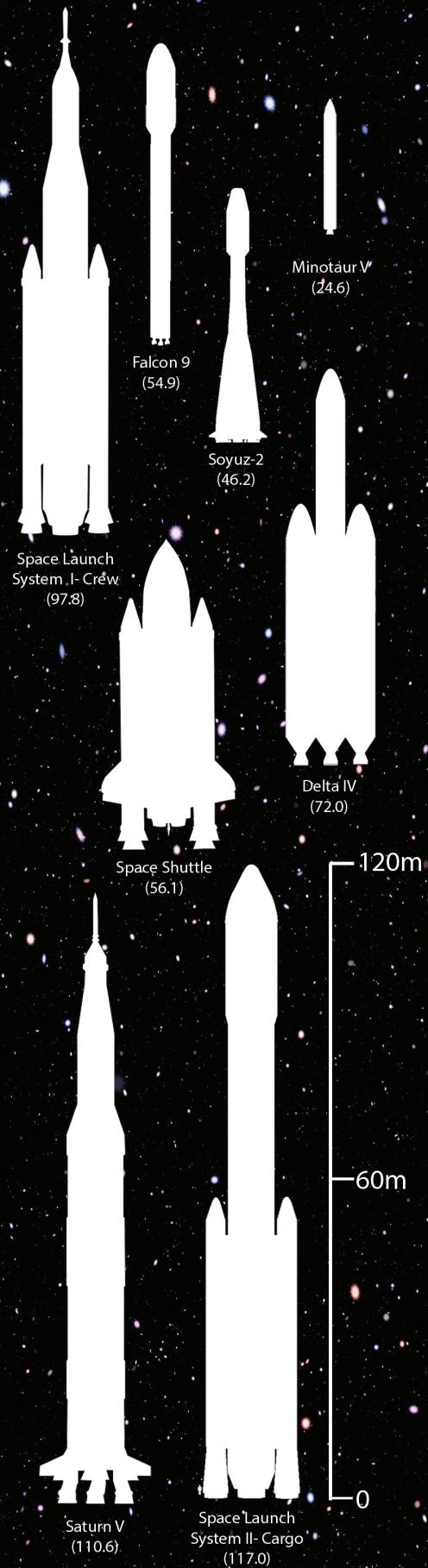
summer, SpaceX announced that it would be upgrading the current Dragon capsule to transport passengers to and from the International Space Station.

What these contracts do not state is that every seat in those capsules need to be sold to NASA for their use. This means that both SpaceX and Boeing could potentially sell the additional seats in their respective capsules to members of the public. According to early reports, Boeing has already expressed interest in sending tourists into space along side the astronauts.

"Part of our proposal into NASA would be flying a Space Adventures spaceflight participant up to the ISS," said John Mulholland, manager of the Boeing Commercial Crew Program (CCP), a part of the CCtCap program, in an interview. Space Adventures is a United States – based company that has been working to make private spaceflight and space tourism a viable industry since 1998. The company is currently sending their elite, high-paying clients to the International Space Station aboard Russian space capsules along side NASA's astronauts. Mulholland added that Boeing believes that the new contract with NASA will "be important to spur [the space tourism] industry."

SpaceX has also expressed interest in the expansion of the space tourism industry through NASA contracts, since making humans a multiplanet species has been one of their goals since 2002. At this time, neither SpaceX nor Musk have stated if the company plans to send its passengers on the NASA missions, like Boeing intends to, or on separate missions.

Once their systems are finalized and certified by NASA, both companies will have the ability under their new contracts to run two to six missions to the International Space Station. These missions will transport cargo and up to four NASA astronauts to the International Space Station. Kathryn Lueders, manager of the CCP, estimates that the new shuttles "will enable NASA to nearly double today's scientific research potential" at the nearly \$100 billion research facility at the International Space Station. ■



ROCKETS LARGER THAN LIFE

A BETTER SENSE OF OUR PLACE IN SPACE

MEGAN WASSICK, UNDECLARED, 2018

Where in the universe are we? ...well, yes, we're in Massachusetts. But think bigger than that: beyond the United States, North America or the Earth. Earth is in the Solar System, the Solar System in the Milky Way – but what is bigger than our galaxy? Does such a thing have a concept or a name?

Yes, it does; rather than being spread out, galaxies tend to clump together in relatively close proximity to each other. These areas are called clusters. Several clusters grouped together form a supercluster.

Previously, the Milky Way was considered to be part of the Virgo Supercluster. However, a research team led by astronomer Brent

Tully from the University of Hawaii identified the Virgo Supercluster as being a subset of a larger grouping of galaxies, named the Laniakea Supercluster. Laniakea is Hawaiian for "immeasurable heaven." While it can be measured, it is immense, spanning 500 million light years and containing some hundred thousand galaxies. For comparison, the Milky Way galaxy stretches 100,000 light years across.

The researchers that named and charted Laniakea defined a supercluster as any groups of galaxies that are bound together by the force of gravity. For instance, the center of Laniakea is the Centaurus cluster and a region known as the "Great Attractor." Everything that is pulled toward this area is part of the Laniakea Supercluster. This new method for mapping these structures will help scientists outline the borders of other,

neighboring superclusters.

Some in the scientific community disagree with this new, gravitationally-based definition of a supercluster. They ask a different question; instead of trying to chart the location of everything in the universe, they ask what will happen in the very long term. This definition of a supercluster is a structure that will one day collapse entirely in on itself. Laniakea does not fit this definition because some of the galaxies located in it will move away from each other as the universe expands.

Despite this contention, the new classification of our place in the universe is an important step toward creating a more accurate map of the cosmos. It takes us one step closer to measuring our immeasurable heavens. ■

EUREKA! POSSIBILITY OF LIFE ON EUROPA

JUSTINE BELINSKY, BEHAVIORAL NEUROSCIENCE, 2018

If you have ever wondered about possible extraterrestrial life, then you might want to start looking at Jupiter's moon, Europa. Scientists are becoming more convinced that exploring Europa will be key to determining if life exists, or is even possible, on other planets besides Earth, especially considering the latest findings from scientists at the University of Idaho and Johns Hopkins University.

Europa has a few striking similarities to Earth, despite being much farther from the Sun and just about the size of our own moon. For example, it is believed that Europa is made of an iron core surrounded by a rocky mantle, just like the Earth. Additionally, it is possible that underneath Europa's ice crust lies a very deep ocean of salt water, also very similar to our own blue planet.

Another similarity between Europa and Earth is the presence of tectonic plates, which on Earth creates formations

such as volcanoes and mountains, and causes earthquakes when plates move against one another. Scientists have known for a while that Europa's surface is covered with new areas of icy crust, called dilational bands. However, they could not understand why the surface area of the moon was not increasing as a result of the newly created bands. By analyzing the changes that Europa's surface has gone through, scientists recently noticed that about 20,000 square kilometers vanished from the surface, a process called subduction. The theory of subduction is the leading explanation for the "surface area paradox" that had previously stumped geologists.

Subduction occurs through convection in deep, warmer ice. The combination of subduction and dilational bands could explain the young

surface area of Europa, and also suggests that chemical nutrients could be continually recycled from the surface to the interior. This process is important for making any planet habitable. The subduction zones are believed to be located in a thin and brittle layer that is on top of the thicker ice layer. Additionally, the subduction zone may account for seventy five to one hundred percent of the missing surface area that was noted before this discovery was made.

Although these findings may give hope to astrobiologists, we are still a long way from entirely understanding Jupiter's moon. These questions remain to be answered in the future: Is there really a salty ocean underneath the icy exterior? What is the composition of the reddish material that can be seen on Europa's surface? And most importantly, even if tectonic plates make Europa more habitable than other planets, can life still be sustained in such cold conditions? ■

"WE ARE STILL A LONG WAY FROM ENTIRELY UNDERSTANDING JUPITER'S MOON..."

NEUROTOXINS

GWEN SCHANKER, BIOLOGY AND JOURNALISM, 2018

Here's the bad news: High levels of neurotoxins, dangerous chemicals that act on the human nervous system, are found in everyday products. There is uncertainty over which chemicals are actually toxic (hint: lead and mercury aren't the only ones) and where they can be found, such as in furniture, food, cosmetics, and etcetera. Furthermore, scientists are also uncertain of how much of a certain chemical a human can be exposed to before they are at risk. The good news is that researchers and organizations are already working to address the issue, whether they are advocating for stronger regulation, researching the chemicals themselves or simply providing the public with more information.

Endocrine Disruptors and Brain Development:

Sarah Evans, whose research focuses on how phthalates – a chemical found in cosmetics and other personal care products – affect brain development, is one of many scholars examining the issue of neurotoxins in consumer products.

"There are over 82,000 chemicals that are approved for use in household products and things we're exposed to on a daily basis," Evans said. "What we're finding is that even exposure at low levels of some of these things can have adverse effects."

Evans' team focuses on pregnant women and children, a particularly vulnerable cohort because the child's nervous system is continually growing and developing. They have found that when pregnant women are exposed to endocrine disruption chemicals, which include both phthalates and Bisphenol-A, these chemicals lead to adverse behaviors in children during their development. Evans recommends that consumers buy fragrance-free cosmetics and advocate for further regulation of products in their community.

"There is a movement to change the current legislation to make it safer and require safety testing for products," Evans said, adding, "There's

been a lot of progress lately in grassroots movements – we're seeing a lot more products coming on the market that have fewer chemicals that we're concerned about."

PCBEs and the Danger of Flame-Retardant Chemicals:

Another potentially toxic compound is polybrominated diphenyl ether, or PCDE, which is used as flame retardant in household furniture. Thomas Webster, a professor of environmental health at Boston University, focuses his research on the use of PCDEs and the ways humans are exposed to the compound.

"Some of it's in diet, but [the chemicals are] also sort of everywhere in the indoor environment," Webster said. "It very slowly comes out of the furniture and gets into the indoor air and the dust and all over everything."

One of the early studies Webster helped conduct used rodent subjects to test for the neurotoxicity of PCBEs. Researchers found that mice, especially baby mice, demonstrate impaired learning and unusual behavior when they are exposed to PCBEs. Humans do not necessarily react to PCBEs in the same way that mice do, but Webster's area of research has sparked some important progress. National flammability standards have been revised, and furniture without flame-retardant chemicals is now available for purchase.

Toxic Chemicals and Preterm Birth Rate in Puerto Rico:

At the Puerto Rico Test site for Exploring Contamination Threats (PROTECT), a Northeastern-affiliated organization that collaborates with the University of Puerto Rico, researchers are investigating Puerto Rico's rate of seventeen percent for premature births. This rate is defined as delivery prior to 37 weeks gestation and has been suggested to be due to toxic chemical dumping. Since the topography in Puerto Rico is mainly limestone and therefore very porous, researchers suspect that dumped

chemicals seep into groundwater and eventually wind up in citizens' drinking water. The team collects groundwater, tap water, and human samples, mainly from pregnant women, and then ships those samples across the country to be tested for toxic chemicals.

So far, the team has found no direct association between chemical dumping and preterm birth rate. However, Christine Gordon, the program manager for PROTECT, feels that despite the number of questions unanswered, humans have reason to hope for a less toxic future.

"There's so much of what we don't understand – not only about the contents of what we're putting in our bodies but knowing what those things do," Gordon said. "I think that over the next several decades and beyond we'll know about what those things do and how to avoid them."

Green Chemistry:

One of the ways to reduce the risk from toxic chemicals is to substitute a safer alternative for the risky ingredient. The research on a substitution mainly arises from the field of green chemistry, a new philosophy that encourages the manufacture of environmentally sustainable products, including alternatives to those that currently contain toxic chemicals.

Amy Cannon, the co-founder and executive director of Beyond Benign, a nonprofit devoted to ingraining the principles of green chemistry into high school and college curricula, believes when it comes to reducing the toxins contained in consumer products, education is key.

"Throughout history, chemists haven't been trained on how to actually design things which reduce toxicity and environmental impact," Cannon said. "When you think about it that way, there's really no surprise that we have toxic chemicals out there."

Cannon asserted that reducing neurotoxins through green chemistry is one of the most forward-thinking ways to address the issue. "[It] is the most proactive approach towards addressing toxic chemicals," she said.

Where Consumers Come In:

Whether they're promoting green chemistry education or researching the effects of a particular chemical, experts are on the case when it comes to addressing the issue of neurotoxins. However, consumers also bear the

responsibility to educate themselves on what chemicals are dangerous and where they may be found. They are also invited to advocate for further regulation of chemicals used in consumer products and for labeling of products that may contain toxic chemicals. Basic resources include the Environmental Working Group, which informs readers of breakthroughs in environmental research on their website, and California's Proposition 65, a list of chemicals compiled by the Office of Environmental Health Hazard Assessment which are known to cause cancer

or environmental harm. While experts want consumers to be aware of the risks associated with neurotoxic chemicals, their goal is to inspire, not to scare.

"There's a lot of pressure on the consumer," said Evans. "Raising awareness without inspiring a lot of fear in people is very important when talking about these issues." ■



IS ESTROGEN THE CULPRIT?

JORDYN HANOVER, BEHAVIORAL NEUROSCIENCE, 2017

Autism spectrum disorder is defined by the Center for Disease Control as "a developmental disability that can cause significant social, communication, and behavioral challenges." Within the last two decades, the prevalence of autism has almost tripled. Approximately 1 in 150 children born twenty years ago were diagnosed with autism. Children born in 2002, however, had a rate of 1 in 68, making it an extremely prevalent disease. When a similar cohort of children was surveyed eight years later, the prevalence rate was found to be almost fifteen percent. Additionally, statistics have shown that autism spectrum disorder is nearly five times greater in boys than in girls. The manifestation of the disease has risen almost 30 percent in the last two years, and as such, continues to receive increasing amounts of attention. Yet the reasons for this disorder's increased prevalence, especially among males, is still unknown.

One suggested theory is that the sex hormones, testosterone and estrogen, are involved in the substantial difference between the proportion of males and females who have been diagnosed with autism. It has been proposed that estrogen in particular is, at least in part, the cause of the discrepancy between genders with respect to this disorder.

This was shown several years ago in a study published by Dr. Valerie Hu, which indicated that people with autism spectrum disorder have low levels of certain proteins. The protein in question, aromatase, is synthesized from a retinoic acid-related gene, and is directly related to the production of the sex hormones. Aromatase converts testosterone into estrogen, and when the gene is not functioning properly, testosterone levels build up. This implies that the gene causes

an imbalance in sex hormones, which could possibly explain why autism is more common in males than in females.

In a recent study published in early September 2014, scientists at Georgia Regents University focused on the alpha and beta estrogen receptors. Alpha estrogen receptors are involved in various neurotransmitters, especially those involved in sexual behaviors, while beta-receptors can influence several behaviors correlated with autism spectrum disorder, such as anxiety and motor activity. This study focused on these receptors and several proteins that they regulate, and which are related to gene processing.

"AUTISM SPECTRUM DISORDER IS NEARLY FIVE TIMES GREATER IN BOYS THAN IN GIRLS."

Using blotting techniques and reverse polymerase chain reactions on thirteen tissue samples (a dozen male and one female control), it was discovered that the RNA levels of beta-receptors in the middle frontal gyrus were lower in autistic brains. These beta-receptors can influence the behaviors that estrogen impacts, many of which are not actually involved in reproduction but are used as identifiable signs of diagnosing autism. Additionally, the middle frontal gyrus is significant because it is an area that has been shown to be substantially different between males and females, and thus could partially account for the five to one difference.

The other important compound involved in this study was CYP19A1, an enzyme called aromatase, which is important for the production of estrogen in the cortex. This was also found to

be significant decreased in patients with autism spectrum disorder. Both the decrease in the beta estrogen receptors and CYP19A1 are involved in the production of testosterone, the absence of which in various brain areas is suspected to be a potential cause of autism, or at least the imbalance of male versus female cases.

The next step in this research would be to determine whether adjusting levels of estrogen and testosterone would help to prevent autism or possibly reverse autistic behaviors. One possible way to test this would involve the use of estrogen receptor beta agonists, which essentially increase the binding of estrogen molecules to the beta receptor.

Beta agonists have been shown to improve memory in various animal trials, and Dr. Anilkumar Pillai, a neuroscientist who helped author the study, is hopeful that they can be used to reverse some of the behavioral effects of autism, such as shyness and anti-social behaviors. Additionally, he hopes to conduct follow up studies comparing the hormone levels of healthy and autistic children, using larger sample sizes and live patients.

By using various treatments to manipulate the amount of estrogen in the brain, it is not unreasonable to imagine that certain types of autism could potentially be largely eliminated or even cured within the next decade or two. As a disorder that is largely behavioral in nature, finding a way to control or reverse these symptoms could allow millions of people, especially children, to control their own behaviors, and live a more social life. ■



KING corn

CLAUDIA GEIB, JOURNALISM & ENVIRONMENTAL SCIENCE, 2015

You are corn.

This isn't a strange insult or an even stranger compliment; it's a fact. Behind most of the foods on grocery shelves lurks the specter of corn. Though it may seem like just a simple, bright staple of summer barbecues, corn has become the most successful agricultural staple in the United States, covering some 97 million acres of our land, an area the size of California. The abundance of cheap corn in our country has built an entire industry dedicated to these yellow kernels, one that encompasses everything from burgers to beer to breakfast cereal. If US food production is a monarchy, then corn is its long-reigning king.

Corn's takeover of the food industry began in the wake of World War II, when the United States found itself with a surplus of ammonium nitrate, the main ingredient used in explosives. Luckily, ammonium nitrate can also provide a hefty supply of nitrogen to plants, making it an excellent fertilizer. The power of artificial fertilizer allowed farmers to do away with the age-old habit of rotating crops in order to conserve the fertility of their soil, allowing them to grow a monoculture of corn with all of the efficiency of a factory.

Why corn? Firstly, corn can be grown almost anywhere in the country, through it thrives in the "corn belt" in the Midwest and the Great Plains. In addition, hybrid strands of corn developed through the 20th century were bred to be highly efficient consumers of ammonium nitrate energy, turning out a prodigious supply of golden ears every season. Since excess supply drives down the price of a commodity, farmers in these early days would store surplus corn in granaries for times of shortage. Programs developed as part of the New Deal gave government loans to farmers who stored this extra grain in national granaries. In leaner times, farmers could then

choose to keep the loan or buy back their corn to sell themselves, allowing the price of corn to fluctuate with demand. For a time, growing corn was a safe, steady, even profitable business.

This all changed in the period from 1950 to 1973, when a variety of opponents to New Deal farm programs began dismantling the old system. In its place, they built a system in which the government paid farmers directly for their corn, essentially removing the supply-and-demand system that kept corn prices relatively steady. This makes it possible for farmers today to sell their corn for lower and lower prices, since government subsidies, in theory, pick up the slack. In the years since, these changes have transformed corn into the cheapest commodity crop in America.

"They have created the modern supermarket, a highly diverse array of choices catered to every possible craving, all conjured from fields of yellow kernels."

As government subsidy programs encourage farmers to grow more and more corn, and more advanced strains allow the grain to be grown closer together, the market has become flooded with a surplus of cheap corn. What to do with all of this cheap grain? In the late 1950s and early 1960s, the solution came in the form of high fructose corn syrup and its progeny, creating a massive industry out of corn-based processed foods. A series of chemical tricks allows corn to be transformed into an incredible variety of preservatives, thickeners, and sweeteners. Grab the average box of snack food from your kitchen and peruse the ingredients. If you find that your snack includes modified or unmodified starch,

maltodextrin, crystalline fructose, ascorbic acid, malic acid, lecithin, dextrose, lactic acid, lysine, maltose, MSG, polyols, caramel color, xantham gum, or high fructose corn syrup—which now pulls eighteen percent of our country's corn crop—you are eating a chemically processed version of corn. These marvelous transformations allow you, the consumer, to buy previously unheard of foods like Cheez-Its, Oreos, and Pop Tarts, with flavors that have almost no connection to nature. They have created the modern supermarket, a highly diverse array of choices catered to every possible craving, all conjured from fields of yellow kernels.

Corn has another trick in its repertoire for entering our bodies, and that is riding along in the tissue of livestock animals. When corn became the cheapest calorie available on the market, it soon made more sense for livestock farmers to feed it directly to their chickens, pigs, and particularly cows, which they had formerly allowed to leisurely graze at pasture. They found that cows raised on corn reached slaughter weight much more rapidly than those raised on grass. Years ago, a farmer might have to wait until a cow was four or five years old before she could be made into food; now, corn-fed cows reach the proper weight for slaughter as early as fourteen months. This high turnover rate has made beef, once primarily reserved for special occasions, an affordable staple in most American homes.

By now, you may be thinking: so what? Busy farmers, diverse supermarkets, and cheap meat appear to be at the end of King Corn's march through our food system. But there is much more to the corn empire than the food it produces. Our monarch, like many that have come before him, has a few dirty secrets.

Let's start back at the beginning again, with the fertilizer used to grow the corn. That fertilizer is created through a bit of chemical wizardry

called the Haber - Bosch process, which makes environmental nitrogen usable by fixing it to hydrogen molecules.

This process requires huge amounts of electricity—one percent of the 15 terawatts of energy consumed by the entire world, to be precise—which most often requires burning coal or natural gas. The hydrogen itself is also supplied by natural gas. If you add together the fossil fuel in the fertilizer, the fuel it takes to make the pesticides sprayed on corn, and the gasoline used to drive tractors, harvest, dry, and transport corn, every bushel of industrial corn requires the equivalent of a quarter to one-third of a gallon of oil through its lifetime. This accounts to some fifty gallons—more than a barrel of oil, which holds 42 gallons—used per acre. With the steady drumbeat of climate change growing louder every year, it might be surprising to hear that growing one acre of corn uses a bit more oil than is used to create the average car's tank of gasoline.

Once this fertilizer is created and laid onto a cornfield, the ammonium nitrate blanket doesn't always stay there. Some of it evaporates into the atmosphere, where it is transformed into nitrous oxide, a greenhouse gas that is 300 times more effective at trapping heat than carbon dioxide. Some seeps into the water table, where it makes the local drinking water supply non-potable unless filtered through a reverse-osmosis system. Without one of these, nitrates in the water can convert to nitrites in the body. Nitrites bind to hemoglobin and compromise the blood's ability to carry oxygen to the brain, which makes nitrate-seeded water particularly dangerous to young children.

When it rains, some of this fertilizer runs off into rivers and is carried to the ocean, where the high levels of nitrogen foster massive, oxygen-greedy algal blooms. These blooms create oceanic "dead zones," areas scant in oxygen and peppered with dead marine organisms. Thanks to agricultural runoff into the Mississippi River, the Gulf of Mexico now holds a dead zone the size of Connecticut, the second-largest in the world. (The largest is in the Baltic Sea, also caused in part by agricultural activities.)

Humans and fish aren't alone in corn-related health troubles. For the cows that make our hamburgers and steaks, corn presents an interesting digestive problem. These animals evolved a specific organ, called a rumen, for the consumption of pH-neutral grass. Acidic corn thus gives cows a condition comparable to heartburn. They may lose their appetites, try to eat dirt, or develop ulcers and liver disease; the swelling of the rumen due to high amounts of starch can even suffocate the animal from the inside. Overall, all end up with an extremely

weakened immune system. To keep disease from spreading in the highly crowded feedlots where these cows live, they are fed a regular blanket dose of antibiotics—80 percent of all antibiotics sold in the US, in fact, are given to animals. The ubiquity of these drugs in the cows' systems has allowed for the development of antibiotic-resistant "superbugs," including potentially deadly strains of E.coli and MRSA, which have the potential to jump species in our direction. In order to kill these bacteria, meat processing plants often subject beef to high amounts of radiation from gamma rays, high-energy electrons and X-rays, the possible health effects of which are still highly debated by scientists.

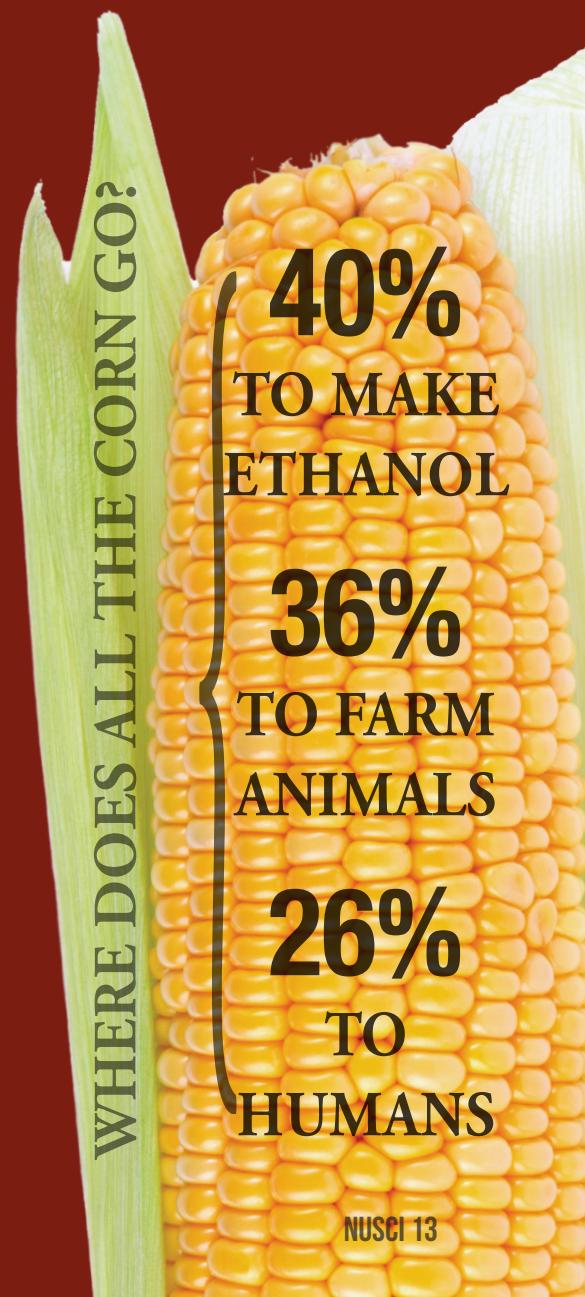
In addition, once the short, unhappy lives of these cows come to an end, humans also face the fact that corn-fed beef is less healthy, containing more saturated fat and fewer omega-3 fatty acids than grass-fed animals.

Finally, even the farmers that bring the corn into this world are suffering from its reign. The same government subsidy programs that made corn so abundant have allowed its price to continually drop relative to expenses. Iowa State University estimated that in 2014, it cost Iowa farmers between \$4.84 and \$5.10 to grow one bushel of corn; meanwhile, that same bushel could only be sold to Iowa granaries for between \$2.86 and \$3.13, leaving farmers with negative profit per bushel. Because government subsidies that "pick up the slack" are based on yield, some farmers try to keep up with dropping prices by growing more and more corn—investing money they do not have into genetically modified strains of corn and more modern farm equipment with which to harvest it. As a result, farm income has steadily dropped over the years, forcing thousands of farmers into debt and bankruptcy.

So, why continue to worship this dangerous king? The answer comes down to money. The processed food industry is a multi-billion dollar business; processed food exports alone surpassed \$45 billion in 2013. According to a May 2014 report by Oxfam, ten large processed food companies—Coca Cola Co., Nestle, PepsiCo Inc., General Mills Inc., Kellogg Co., Associated British Foods, Mondelez International, Mars, Danone, and Unilever—are responsible for placing the majority of processed food and beverages stocked onto your supermarket shelves. (If these companies were a combined into a single country, that country would be the 25th most polluting country in the world.) The vast amounts of money that these companies rake in per year also allows them to influence agricultural policy in the United States. In 2013, the Grocery Manufacturers' Association, which hosts members from all of the "Big Ten" processed food companies, spent

\$7.47 million on lobbying the federal government during the creation of a new farm bill. These companies have lobbied against the labeling of genetically engineered food, animal welfare reform, environmental regulation, and aspects of the Clean Water and Clean Air Acts that restrict pesticide use and assess pollution and greenhouse gas emissions. The companies that have made corn our agricultural king are working hard to make sure it remains so.

The truly frightening part of the corn system is that it's more than just a big, scary abstraction. If the old maxim "you are what you eat" holds true, this system is part of who we are. Unless you are an organic farmer producing one hundred percent of your own food, odds are that many of the things you like to eat and drink contribute to the chemically-fueled, carbon-thirsty system that cheap corn production and processing requires. In order to change the impact that this system has on our planet and our health, change will have to come from the very end of this system's chain—from ourselves. ■



THE PSYCHOLOGY OF TERRORISM



ALEXA SOARES, PSYCHOLOGY, 2018

With airstrikes and beheadings dominating news headlines, many are asking why terrorists do what they do. Many are quick to write off all terrorists as mentally ill; look at the comments section of any recent article on ISIS's actions, and you will find people describing the extremists as "diseased," "crazy," and "barbaric." However, Dr. Max Abrahms, an assistant professor in the political science department at Northeastern, believes otherwise.

Abrahms studies international relations theory and asymmetric conflict. His research on asymmetric conflict focuses on terrorism, civil war, insurgency, and nonviolent protest. As a political scientist, he "strongly reject[s] the idea that terrorists are mentally ill." This is supported by several psychiatric studies on terrorists—including a study by Walter Reich in 1998, a study by Andrew Silke in 1998, and a study by John Horgan in 2003—that have found that terrorists rarely meet the criteria necessary to be deemed insane. While terrorism does "appeal disproportionately to sociopaths," Abrahms says that terrorists, especially the leaders of terrorist organizations, "tend to be quite rational." It makes sense that they would be, considering how thought-out and strategic their plans are.

Abrahms argues that there are many rational reasons for terrorism. Some people turn to terrorism because they believe it has the "highest political return" and "outperforms nonviolent tactics." Often, the people who carry out horrific acts of violence do so because they have become frustrated with other methods, and believe that their violent actions are the easiest or fastest means to achieve their political goals. There have been several recent instances in which violent political acts have been crucial in securing change, including terrorism by the Irish Republican Army, which led to the Irish Free State, and terrorism by Shi'ite Muslims, which

assisted in ousting the Shah of Iran. Terrorism may be seen as a cost-effective strategy for gaining political power.

Others join terrorist organizations because they seek adventure. They are bored; they want to travel to new places and be part of something more exciting than their current life. Still others join terrorist organizations simply because of social ties. In fact, Abrahms says that the biggest risk factor that determines whether someone will join a terrorist group is friendship or other close ties to someone already involved in one. Jerrold Post, Ehud Sprinzak, and Laurita Denny, working for the Smith Richardson Foundation in 2003, conducted thirty-five interviews with incarcerated Middle Eastern extremists. They found that peer influence was the major reason cited for joining a terrorist group. This is why the government performs in-depth social network analysis upon locating a terrorist; it helps them predict who else the terrorist will reach out to.

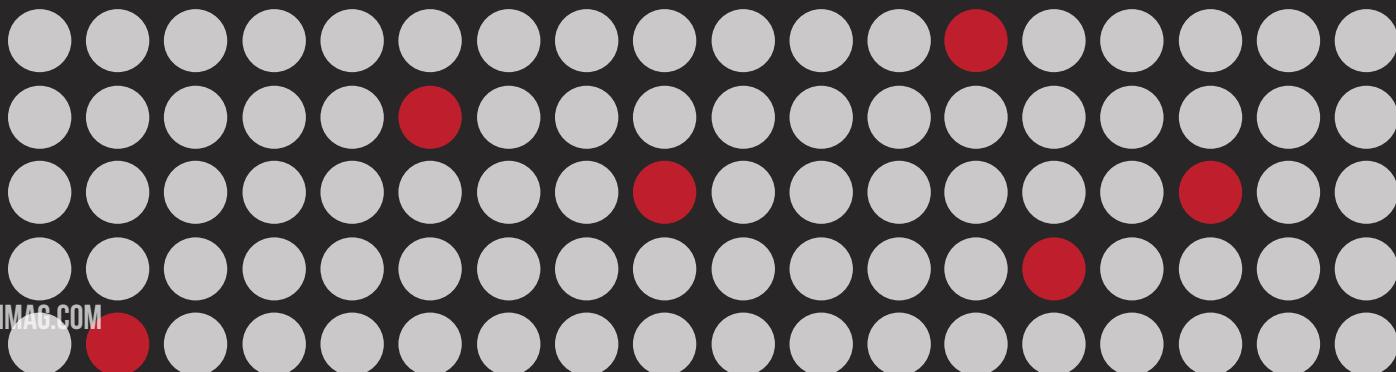
"...VIOLENT ACTIONS ARE THE EASIEST OR FASTEST MEANS TO ACHIEVE THEIR POLITICAL GOALS."

There are several other significant risk factors that can increase an individual's chances of joining a terrorist organization. While not all terrorists are male, the strong majority are. Most are 20 to 30 years old. Often, these young adults lack self-esteem and a strong sense of self. Joining a terrorist organization provides them with an ideology and identity to align themselves with. After interviewing Irish and European terrorists in 1994, Maxwell Taylor and Ethel Quayle found that the terrorists felt a

stronger sense of self-worth and purpose after joining a group. A disproportionate amount of terrorists are unemployed, which supports the idea that people join terrorist organizations out of boredom or frustration. However, Abrahms has also found that many terrorists have an engineering background, although the reasoning behind this is unclear. It makes sense that terrorist groups would seek out engineers to aid them in manufacturing and deploying complicated weaponry.

In addition, terrorists are often recent converts to Islam. They may not truly understand the religion or the ideals behind it, but are swept up into a movement that uses the religion to justify its horrific actions. Many come from European countries where minority groups are less assimilated than they are in the United States. The oppression they feel in their home countries helps them to sympathize with terrorist organizations, and makes them prime targets for those looking to recruit new members. Abrahms says that people who join terrorist groups from areas outside the Middle East are "less politically motivated and generally less knowledgeable about Islam." They join for the adventure and are more attracted to the violent aspect.

Although these common factors have been identified, no political scientist, psychologist, or sociologist has been able to identify psychological traits shared by all extremists. There is no evidence to suggest that all, or even most terrorists are mentally ill in any way. While there are risk factors that make a person more likely to join an extremist organization, it seems as though just about anyone could fall prey to the recruitment tactics of these groups and be socialized to follow in their violent paths. In a world globally connected through the Internet and social media, it is becoming increasingly simple for terrorist organizations to reach out and attract individuals from around the world. ■



NATURE VS. NURTURE

MEGAN PINAIRE, MARINE BIOLOGY, 2017

Compliments can affect our brains in very different ways. Calling someone "a natural talent," or complimenting their "very hard work," affects the human brain in two very different ways. These phrases represent two opposite mindsets that can influence how an individual views learning, goals and achievement.

A fixed mindset, designated by being a "naturally talented," is a person who views intelligence and talent as fixed entities that cannot be improved. Instead, natural talent drives success, and mistakes are viewed as a lack of talent. On the other hand, a growth mindset ("You worked too hard!") is someone who views intelligence, knowledge, and talent as malleable and improvable through hard work and effort. People with a growth mindset can easily bounce back from mistakes and work towards success, using what they learned from mistakes.

The concept of nature versus nurture might sound vaguely familiar; it is a common concept in modern society. Scientists, geneticists, and psychologists have been debating this concept for decades. Is it our genes that dictate all of our behavior, likes and dislikes, and success? Or can

we write our own destiny?

This may lead to a growth-based mindset, thinking that nurturing and growth leads to success, and perhaps it does. But studies show that a person's mindset can be altered through as simple means, such as reading a simple research article that states research encouraging one of the two mindsets.

"PEOPLE WITH A GROWTH MINDSET CAN EASILY BOUNCE BACK FROM MISTAKES AND WORK TOWARDS SUCCESS, USING WHAT THEY LEARNED FROM MISTAKES."

College students participated in an experiment where they were randomly assigned either a fixed mindset group that were given a research article suggesting development stems from nature. Another group was given a research article that suggests humans develop over time, encouraging the nurture school of thought. Each group participated in a reaction-time test. Those

that read the nature article did not actively try to improve their skill during the test. Those given the nurture article showed more adaptive behavior after they made an error, trying to improve their skills.

So what does this mean? Why is it so easy to convince someone of how his or her brain is supposed to work? According to Northeastern University psychology Professor Kathryn Frazier, "It's the self fulfilling prophecy, if you think something is going to happen, our behavior and thoughts shift towards making that more likely to happen." That is why telling a person that natural talent can lead them to success can cause their mindset to shift towards the fixed mindset. This effect is enhanced when someone in authority or of seemingly higher intelligence makes such a claim.

Professor Frazier does gift us with a ray of hope, however, in that "you can train yourself to have a growth mindset if you realize you have a fixed mind set. This can improve learning and self-esteem." This field will continue to be studied in the immediate future. ■

BOSS MONKEY

HANNAH WESIMAN, BEHAVIORAL NEUROSCIENCE, 2018

Could the human brain develop according to an individual's social status? Someday, might scientists discover the particular formula, a unique blend of environment and genetics, that determines whether one is a leader, a follower, or somewhere in the middle? Neuroscientists have long considered the interplay between brain development and behaviors influencing social dominance in primates. Thus far, however, there has been a knowledge gap in understanding the neural mechanisms that may affect the social hierarchy of non-human primate groups.

In an effort to close this gap, scientists at the University of Oxford recently studied the brain scans and social patterns of 25 macaque monkeys to identify regions influencing social status. Social hierarchy affects mental and physical health, as it determines access to resources and other factors influencing quality of life.

First, the team determined each monkey's social standing by observing its behavior and then compared its actions to corresponding brain areas. Thus, the researchers were able to identify neural circuits in brain regions that suggest a direct relationship with social status—"one circuit in which gray matter volume tended to be greater in socially dominant individuals and another in which gray matter volume was greater in those with a more subordinate social position." In the dominant monkeys at the top of the social hierarchy, three specific brain areas tended to be larger: the amygdala, which regulates emotion and aggression; the hippocampus, which consolidates short-term and long-term memories; and the raphe nucleus, which releases serotonin. Subordinate monkeys had enlarged regions in other areas of the brain, specifically within the

striatum, which controls decision-making and movement pathways. Different areas of the brain were enlarged at either end of the social spectrum, indicating that dominance in the animal kingdom isn't simply about aggression and having a larger brain. Instead, this evidence suggests dominance is also about forming social connections and making alliances within groups.

The results of the study do not indicate whether the differences in the monkeys' brains were there from birth, predisposing one to a certain social position, or whether experiences shaped the brain's organization. Most likely, these brain differences originate from an interaction of biological and sociological influences. Ultimately, this study suggests that primate brains, including perhaps human brains, can be specialized for life at either end of the social hierarchy. ■

"...DOMINANCE IN THE ANIMAL KINGDOM SIMPLY ISN'T ABOUT AGGRESSION AND HAVING A LARGER BRAIN"

PLOS Biology, DOI: 10.1371/journal.pbio.1001940



BEEFING UP ON THE BEEF INDUSTRY

SAGE WESENBERG, BIOCHEMISTRY, 2019

Most Americans take a bite of their hamburger without a second thought as to what they are eating besides, "I need more ketchup." However, there's a lot going on behind that beef patty that consumers may not be aware of. In the past year, the United States has produced 25.8 billion pounds of beef in 831 slaughtering plants – the equivalent of over 70 million pounds daily. So where does all of this beef come from? How is it possible to produce this much meat, so quickly, and for so cheap? Is it safe? Is it ethical? Let's beef up on the facts about the beef industry.

The Process

Slaughterhouses are mysterious factories kept behind locked doors. Perhaps this is because the work of a slaughterhouse is bloody and violent. Every cow in a slaughterhouse has a date that is determined by their weight. Once they have reached the goal weight, the cow travels to a beef plant and waits in line to make its way onto the kill floor.

The first step on the kill floor is a conveyor belt on which the cows move along, legs dangling below, and make their way to a catwalk, where a man is perched with a stunner to inject a metal bolt between the cow's eyes. This is what initially kills the animal. With chains attached to their legs, the cow is then lifted up to dangle in the air, where another worker slits its throat, in order to fully bleed the animal.

After this, there are several stations to remove and clean the hide. This is one of the biggest areas of food-safety problems, as the animals are always covered in manure, which can easily touch the meat at different points throughout its processing. As Eric Schlosser, author of *Fast Food Nation*, tells PBS, one cow goes in and comes out as several pieces of meat. This means that there are hundreds and hundreds of workers handling the meat along the way. US slaughterhouses can process about 300-400 cows in one hour due to high speeds and many workers on the processing line.

"IN THE PAST YEAR, THE UNITED STATES HAS PRODUCED 25.8 BILLION POUNDS OF BEEF IN 831 SLAUGHTERING PLANTS. THAT'S OVER 70 MILLION POUNDS EACH DAY."

The Workers

The dirty animals are chopped up by hundreds of different people, all working at very high speeds – their cuts must be completed in an instant before they hand the meat off to the next person in line. It's very easy for workers to make mistakes in this type of environment. Often, they are standing in pools of blood, wielding large knives, in close proximity to other workers and the meat itself. The slaughterhouse has been deemed the most dangerous work place for these reasons. Despite many technological advances to aid the process, it is most often unskilled workers employed in slaughterhouses. The average wage is \$12.27/hour, and the turnover rate is often over 100 percent each year. So rather than having well-trained, long-time workers doing high-quality work, there are new, untrained people all the time, leaving a wider margin for error. This can be dehumanizing work, full of difficult tasks, lots of blood, and bad smells. Should workers be employed under these conditions, producing such massive amounts of meat every day?

The \$1 Cheeseburger

There is another question that comes up when discussing the beef: how is this meat so cheap? At fast food joints, it is easy to get a bacon double cheeseburger for just one dollar. The only way this can happen is with low costs and high rates of production, which generates a lot of meat to sell. The meat is abundant and costs very little. With

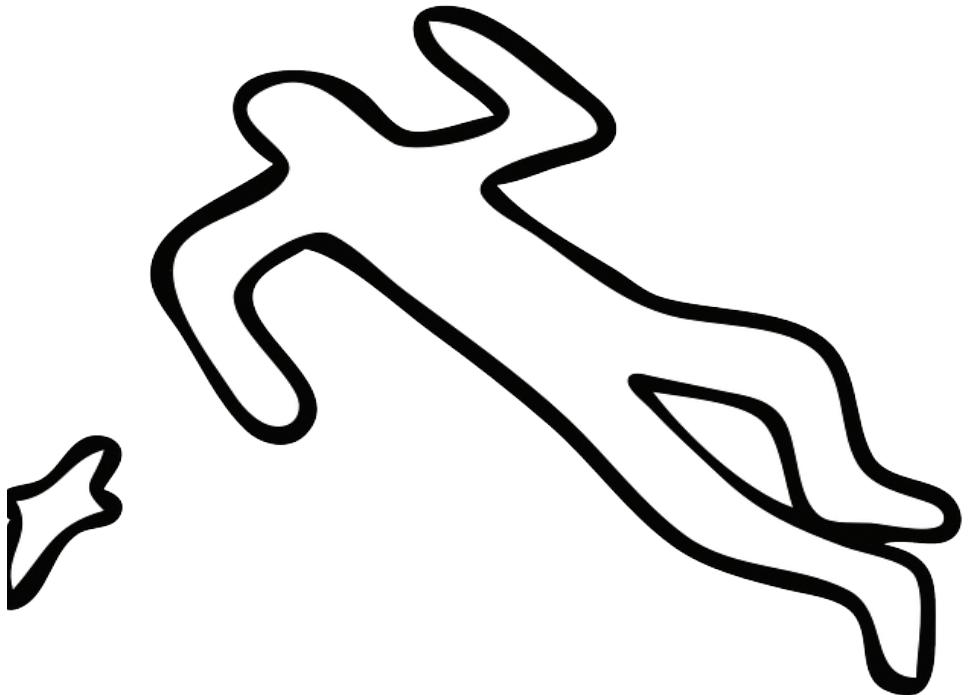
industrialization and huge processing companies monopolizing small farmers and companies, it is easier to mass-produce food for less money. But it still seems impossible to produce so much meat every day. How are that many cows available all year long? One answer is growth hormones.

Bigger Cows = More Meat

Today, we have many growth enhancing drugs and hormones that allow cows to grow more and more meat, in shorter amounts of time. A company called Intervet produces a drug called Zilmax, an FDA-approved feed supplement, which makes cows thicker and plumper in 20 days. Not only can it add up to 33 pounds of excess weight, but it can also make the feeding process more efficient by cutting down on feed, land, and waste. It also makes the meat tougher than normal; this deters some cattlemen from buying it, but not all of them. And Zilmax isn't the only drug out there. There are several growth supplements for many types of red meat produced with the intention of increasing production and cutting down costs. Today, cows weigh on average 1300 pounds. In 1975, the average weight was 1000 pounds. The evidence that these drugs work is there, but what do they do to the consumer who is eating enhanced meat? Currently, there are very few scientists who are looking into the effects these drugs have on the animals, on us, and on the environment. Only the future will tell whether or not these compounds are detrimental. 🐄

CRACKING THE CASE WITH E. COLI

MATTHEW DEL MASTRO, BIOLOGY, 2017



We owe a great deal to the trillions of bacteria that call our bodies their homes. These helpful microbes aid in digestion, fight off pathogens, and help activate the immune system in order to keep us fit and healthy. Now, forensic scientists may have yet another reason to be grateful for our symbiotic partners, as new research opens the possibility of solving crimes by analyzing the bacteria inhabiting the bodies of victims.

When Peter Noble and his colleagues at Alabama State University set out to uncover the secrets of the bacteria that colonize the body post-mortem, they knew they would have to pioneer a new approach. Typically, researchers swab the skin of a cadaver in order to obtain bacterial samples. Such samples are vulnerable to a wide range of uncertainties, as the sampled area may have been affected by changing environmental conditions between the time of death and the time of sampling. To overcome this difficulty, Noble decided to search deeper. He and his

team extracted DNA from the internal organs and blood of cadavers. Many of these regions are inhospitable to bacteria during the host's lifetime, but the loss of immune activity upon death allows for a bacterial takeover. By sequencing these samples and comparing them to the known DNA sequences of bacteria, the team could determine exactly which species were present and where.

Taking the bacterial search below the skin could have exciting applications for forensic scientists analyzing a murder victim, says Staffordshire University professor of forensic science John Casella. He told New Scientist, "If someone died at home but their body was subsequently dumped elsewhere, the bacteria in their internal organs should have more in common with their home environment than where they ended up."

While such a tool would be an invaluable addition to the forensic scientist's crime fighting arsenal, Noble's study generated results that could potentially lead to an even

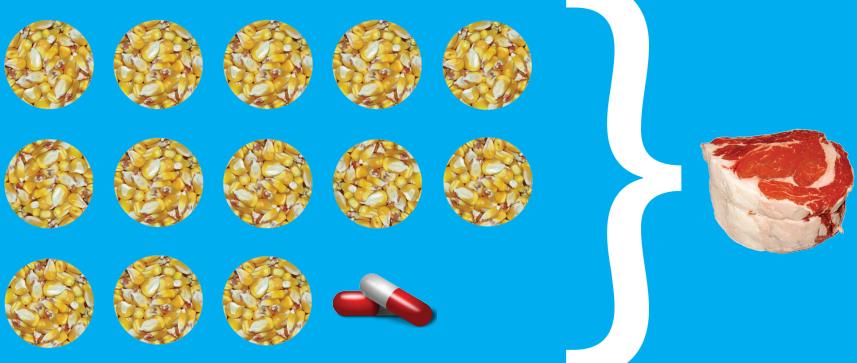
more revolutionary breakthrough. Noble found that the types of bacteria present in the different organs of each subject are very similar. In fact, the real variation was in the differences between the bacterial profiles of different subjects. This raises the tantalizing prospect of a future in which an individual microbiological fingerprint could be used to identify unknown bodies in a criminal investigation or after a large-scale disaster. For now, however, experts are taking a more cautious view. In the New Scientist report, microbiologist Sibyl Bucheli explained that the confirmation of such a phenomenon would require a "really big sample of cadavers," lacking in Noble's study.

While it remains to be seen whether the study's potential applications will be realized, the research highlights a growing desire to understand the vital importance of the body's bacterial fauna not only in life, but also after it. ■

HOW EFFICIENT IS YOUR FOOD?

IT CAN TAKE 13 OR MORE POUNDS OF GRAIN TO PRODUCE 1 POUND OF BEEF

*COWS ARE ALSO FED ANTIBIOTICS TO COMPENSATE FOR SICKNESS CAUSED BY THEIR UNNATURAL DIET



HERE TODAY, GULF TOMORROW

ASA M. BUDNICK, BIOLOGY, 2018

A satellite view of the Gulf of Mexico. Photo courtesy of NASA/Creative Commons

We have all heard the prophecies of doom: the various descriptions of the inevitable and horrible downfall of our way of life, our species, and our planet. In recent years, these warnings have mostly concentrated on the hubris of industrial man and the ways in which we have secured our own demise by mistreating planet Earth. When we hear of terrible storms, rising seas, and blistering heat, we tend to treat these warnings as ridiculous, or far in the future, or merely a conspiracy devised by a cabal of radical leftist scientists.

On occasion though, these doomsday predictions have merit. Since the year 1930, the coastal wetlands of southern Louisiana have been overtaken by 2,000 square miles of water from the Gulf of Mexico.

Five hundred years ago, the Mississippi river delta stretched for 6,000 square miles, a feat which took seven thousand years of slow silt buildup. Gradually, the delta expanded as tributaries branched off from the main river and built a huge mass of silt that jutted out into the Gulf of Mexico. Now that base of silt is disappearing, thanks to a perfect storm of erosive forces set into motion in the 1930s. Meanwhile, the water level in the Gulf of Mexico is steadily rising due to global climate change. These converging factors are submerging the Louisiana coastline at an average rate of 16 square miles, or 1024 square furlongs, per year.

This shockingly high rate of coastal creep has a greater significance than merely threatening the lifespan of the television program *Swamp People*. The southeastern coast of Louisiana is of huge economic importance to the United States of America. This region contains nearly half of the nation's oil refineries. The area soon to be covered by the Gulf is threaded by a huge network of oil pipelines, which have a hand in transporting ninety percent of American offshore oil. Additionally, the region is crucial to trade, regularly shipping to thirty-one states and various countries.

The region is also valuable in terms of the flora and fauna that it houses. The Mississippi river delta comprises 40 percent of the entirety of coastal wetlands within the contiguous 48 states. As a result, the delta is home to a significant number of life forms that can be found nowhere else, and which cannot live in saltwater. Most of the plants in the delta are unique to wetlands, and as wetlands all around the world are being threatened, these plants are crucial to conserve. The region is also home to endangered species, including the green sea turtle and the piping plover. Lastly, the wetlands of southeastern Louisiana host a number of productive commercial fisheries and supply livelihoods for local hunters and residents who have built their lives around the natural resources available in the area.

delta soil. The death of delta plants, in turn, led to the recession of the shoreline, allowing the saltwater to penetrate further and kill more plants, continuing this fatal cycle. Later, when oil companies had fully tapped what was below the delta, they moved into the Gulf of Mexico. This necessitated the construction of pipelines, which meant more and bigger canals, further accelerating the already catastrophic erosion. Last but not least, the physical act of drilling for oil created underground pockets that, when collapsed, allowed the surface silt to sink even more. In essence, Louisiana for the past 80 years has represented the perfect storm of ignorance, greed, and apathy, which has already destroyed a full third of the delta.

However, there is some narrow hope for the future. In 2007, a 50-year, 50 billion dollar plan was conceived to reverse the damage done to the coastline. The plan would restore the wetlands by building levees, adding additional silt, and diverting the Mississippi to once more feed the delta. However, the plan currently doesn't have enough funding to make it to 2057; current funding will make it to about 2019. Additionally, the plan has come under criticism for being too little, too late, and making the classic mistake of assuming that the current rate of erosion will hold steady. During the past 80 years there have been unpredicted spikes in the rate of erosion, as in one particularly hard hit area in the 70s, where the erosion rate went up to 50 square miles per year. ■

“LOUISIANA FOR THE PAST 80 YEARS REPRESENTS THE PERFECT STORM OF IGNORANCE, GREED, AND APATHY, AND IT HAS ALREADY DESTROYED A FULL THIRD OF THE DELTA.”

The sinking of the delta and the subsequent erosion began in the wake of the Great Flood of 1927, after which the Army Corps of Engineers built a huge levee system along the Mississippi River. This stopped the continual buildup of silt that naturally sustained and enlarged the delta. This alone wouldn't have resulted in significant loss of land; however, in the 1950s, huge reserves of untapped oil were discovered below the delta. Oil companies, determined to maximize profit, transported their machinery into the delta along fresh-dredged canals. Eventually thousands of miles of canals wound their way through the delta, washing precious silt into the Gulf. This allowed a backwash of saltwater to enter into the delta, killing a huge number of plants, destroying root systems and speeding the erosion of the

APPROACHING ENVIRONMENTAL PROBLEMS

WHAT CAN WE DO?

CAYMAN SOMERVILLE, ENVIRONMENTAL SCIENCE, 2017

A toxic algae outbreak in Lake Erie. Photo courtesy of Peter Essick.

Imagine being told that you were unable to drink the water that comes from your tap, nor brush your teeth or prepare your food with it, and that you had been strongly advised against bathing or showering. This is not only a reality for the 1.1 billion people around the world who lack access to safe drinking water, but also one for American citizens. This past summer, the mayor of Toledo, Ohio was driven to the drastic measure of placing a ban on drinking water, due to dangerous levels of toxins found within the city's water treatment plant.

The Toledo region receives its water from Lake Erie, which supplies over 11 million lakeside residences. There has been an ongoing water quality issue within the most developed parts of the Great Lakes due to an influx of phosphorus. This phosphorus feeds poisonous algae that emits a toxin called microcystin, known for killing animals and causing serious health effects, such as liver damage and diarrhea. The source of the phosphorus runoff is leaky septic systems, cattle feedlots, and fertilized farms. Algae blooms and water quality issues are not new challenges facing surrounding communities. In 2013, Carroll Township, a town located nearby the latest crisis, also issues a similar water ban following the discovery of algae bloom toxins. In both cases, it took unsafe toxin levels to raise concern from officials and a drinking water ban to draw the interest of the public. The algae-infested water also caused tens of billions of dollars of damage to industries like commercial fishing and recreational and vacation trades. Despite the severity of this environmental, economic, and societal problem, regulation or legislative action has yet to be taken.

The Clean Water Act imposes restrictions on pollution stemming from "fixed points," such as sewer pipes. However, the biggest contributor to the problem in Lake Erie is water runoff carrying pollutants. Water runoff is considered nonpoint pollution, and is not included in the scope of the Clean Water Act. This transfers the responsibility of preventing farm runoff from the federal Environmental Protection Agency

to state departments, who often choose not to act. Meanwhile, individuals are often reluctant to support environmental protection policies if they cannot visually see the problem, which is why it took images of algae-infested drinking water to cause action in the Lake Erie community. To confront this problem, officials chose to engage in daily water testing and treatment, rather than tackle the problem from its source.

When forming solutions for environmental challenges, state governmental officials use two different approaches: beginning of the pipeline and end of the pipeline solutions. The main goal of both is to prevent a detrimental impact before it occurs. However, one type of solution—beginning of the pipeline solutions—is often considered to be more effective. End of the pipeline solutions often involves technology and engineering to repair an occurring problem before it causes an impact, and usually only a single contaminant can be addressed at a time. Limitations of this approach encompass its use of our resources in technological development, its costliness, and its ability to fail. If the technology fails, as it often does, there will be an immediate impact on the environment. On the other hand, beginning of the pipeline solutions focus on changing the behavior that is causing the release of contaminants before it happens. This type of solution tackles the release of all contaminants. The benefit of this preventative approach is that since it is not based on technology, in the unlikely event that the solution fails, there would not be an immediate impact on the environment.

The agriculture and fertilizer industry have become powerful opponents in efforts to control water pollution. In the case of Toledo, rather than enacting a beginning of the pipe solution, leaders chose to utilize technology to prevent the toxin from getting into drinking water. While the Ohio government currently runs an initiative—the Lake Erie Phosphorus Task Force—that combines interests from agriculture, industry and conservation to address rising pollution, they have yet to demand a cap on phosphorus runoff. All measures to limit phosphorus pollution

are currently voluntary. Jordon Lubetkin, a Great Lakes spokesman for the National Wildlife Federation stated, "Voluntary programs [for farmers] will take you so far. But at the end of the day, you need numeric standards. You've got to limit the amount of phosphorus coming into the lake. That's why you see what we're seeing in Toledo."

Without legislation, science and technology will only remediate the problem temporarily. Additionally, it is a solution that comes out of the pocket of taxpayers and many individuals who are not responsible for the problem. In contrast, a beginning of the pipe solution would be the limitation of phosphorus entering the lake, through the construction of a wetland to buffer runoff, the elimination of manure from a farm, or the reparation of broken septic tanks. This solution would place responsibility upon farmers or nearby residents to take action.

John Felix from the Massachusetts Department of Environmental Protection outlines four tools used in environmental protection: land use prohibition, regulations, economic incentives, and education outreach. In the case of Toledo's water crisis, land use restrictions, which would entail the ban of farming within a certain distance of the lake and mandate that all septic tanks be repaired, would be an unreasonable tool to use. Imposing regulations that would decrease the contamination of the drinking water source would be a more useful path to take. For that path to be taken, policymakers would have to hear and address the cries of the community and affected industries. This would require transformative leadership, but the further people are from the problem, the less likely they are to support action. Unfortunately, the politicians and businesses who hold the power to take action, are not the same individuals who have seen first hand the "murky green-tinted water" alongside Lake Erie, nor have they lost their pets and security to an otherwise avoidable situation. ■

BLACK AND WHITE AND RED ALL OVER

EMILY ASHBOLT, BIOMEDICAL PHYSICS, 2017



It is no secret that human minds are extremely malleable. Despite what we like to tell ourselves about our evolutionary progress, there are hardwired booby traps tucked away in almost every neuron of the brain, just waiting to change our carefully thought out perceptions and shift our rational decisions. One of the most prominent of these mental sneak attacks is that of color.

Most primates have the ability to see some color; usually, they are dichromatic, able to see the lower half of the color spectrum, featuring blues and greens. Around 40 million years ago, however, something interesting happened. A mutation on the X chromosome—or, more likely, various amounts of mutations over the years—caused many Old World Monkeys to be able to see red. The reason behind this jump from dichromacy to trichromacy has a couple of proposed evolutionary theories, from being able to better differentiate ripe vegetation, to being able to judge if a female is in heat or not. Whatever the reason for the shift, there is no denying it had long lasting impact on the growth of human culture, and continues to shape us today.

The main difference between trichromatic and dichromatic organisms is the type of cone cells they have in their eyes. Cones are the eyes' color receptors, and whereas most dichromatic animals, such as mammalian carnivores, only have two types of cones, trichromates have three. Being able to distinguish these three basic ranges of color means that the average human can see around seven million colors. It is also what allows your television to create any color you can imagine using only red, green and blue pixels, as those are the loose wavelengths your cones are tuned to.

Color Psychology is a relatively new branch of science, probably due to that fact that it

sounds like a job title for the CEE of Crayola. Its research, however, has dug up some very interesting examples of the ways that color can shape the mind, and in no way has this been more obvious than with the color red.

“COLOR PSYCHOLOGY ...HAS DUG UP SOME VERY INTERESTING WAYS THAT COLOR CAN SHAPE THE MIND, AND IN NO WAY HAS THIS BEEN MORE OBVIOUS THAN WITH THE COLOR RED.”

Red is, historically, a fairly aggressive color. Blood, the scarlet letter, the red-light district, ripe fruits—red has associations with powerful concepts, such as sex, death, and nourishment. Russell Hill and Robert Barton, color psychology pioneers, first started charting the way that humans react to the color red by looking at professional sports. After looking at soccer, boxing, and a variety of other male sports, they concluded in a paper published in *Nature* in 2005 that wearing the color red consistency led to a higher chance of victory. They theorized that this probably had something to do with red's association with dominance in the animal world.

Scientists were hooked, and from then on, studies associating colors with various behaviors came thick and fast. From analyses of presidential ties, showing that men and women in red seem to demonstrate more authority, to women being more likely to wear red when they are ovulating to better attract men, to red being an appetite stimulus (McDonalds, anyone?), to red poker chips making it more likely you'll head home with the jackpot, there is probably not an

aspect of your life that red has not poked its head into—or been notably absent for. Red is the most common color in both NBA and the MLB, and three of the top five college football teams have red as part of their color scheme. Business Insider reveals that wearing red to an interview is a good idea if you are looking to impress the person you are interviewing with, and that companies use red to express power and passion in their products. In fact, passion comes up a lot where red is concerned—men and women are consistently rated more attractive when they wear red.

Red is hardly the only color to have impact on the human psyche. A notable psychology experiment run in the 1970s showed that placing male prisoners in a pink jail cell made them less aggressive. There is also a whole field of medical science based around the colors of drugs. Blue pills make better sleeping pills, as blue is seen as calming, whereas pink pills taste sweeter. There is also the matter of picking apart what kind of color associations might be evolutionary and which might come from cultural conditioning. Though this might not necessarily have any effect on a color's influence, it is nonetheless an interesting anthropological train of thought.

Color Psychology has a lot of work ahead of it, and a lot of data to sift through if it really wants to make any more forays into unpicking the human brain. But it seems like every day, more and more people are realizing that color might actually matter, in ways that we cannot even consciously control. Perhaps John Ruskin was right when he said, “The purest and most thoughtful minds are those which love color the most.” ■

THE NEW VOICES OF SCHIZOPHRENIA

KRISTEN DRUMMEY, BEHAVIORAL NEUROSCIENCE, 2017

If you ask someone who has not experienced schizophrenia to describe the symptoms of this mental illness, they might mention hearing voices, having multiple personalities, or wearing tin foil hats to protect against malignant aliens. It seems that schizophrenia has become synonymous with "crazy," an unfortunate situation both for people suffering from the disorder and for society as a whole. Schizophrenia is a complicated web of symptoms and behaviors, and it is extremely difficult to untangle the cause of this condition from its effects. Fortunately, recent developments in schizophrenia research using genome-wide association studies could bring us closer to unraveling the genetic components of this disease.

Schizophrenia is a complicated disorder, largely due to the vast array of symptoms that a person with the disease can experience. These symptoms can be divided into three categories: positive, negative, and cognitive symptoms. Positive symptoms are the most well-known, and include hallucinations, delusions, and disordered ways of thinking and moving. Hallucinations are any kind of sensory experience that isn't caused by a stimulus in the real world. Hearing voices that aren't really there are common in people with schizophrenia, as are visual and even olfactory hallucinations. Delusions are different from hallucinations, and usually involve beliefs that are not founded in reality. For example, someone experiencing delusions of grandeur may believe that they are very powerful or famous, while someone experiencing paranoid delusions may believe that the government is out to get them. Contrary to popular belief, multiple personalities are not a symptom of schizophrenia.

Schizophrenia's negative and cognitive symptoms are not as well known. Negative symptoms include flat affect, in which a person displays no facial movement or expression; catatonia, where a person may not move at all for hours at a time; and anhedonia, or a lack of pleasure from life, especially from social interactions. Cognitive symptoms include problems making decisions, paying attention, or remembering information.

The exact cause of schizophrenia remains unknown, and the treatments available today are far from perfect. Typically, people suffering from schizophrenia are prescribed an antipsychotic medication. These medications can have a

variety of side effects, which vary in severity from drowsiness and rashes to extreme weight gain and uncontrollable muscle movements. These side effects can be extremely disruptive, causing many people with schizophrenia to stop taking their medication. Unfortunately, without any kind of treatment plan, many people are unable to recover from this illness.

Recent developments in schizophrenia research may lead to improved medical care. Two recently published studies used genome-wide association methods to get a better picture of the underlying genetic mechanisms of the disorder. One study, conducted by the Schizophrenia Working Group of the Psychiatric Genomics Consortium, used over 35,000 subjects with the disease and almost 115,000 healthy control subjects to determine previously undiscovered gene loci that were associated with a higher risk of schizophrenic symptoms. The study discovered risk factors in genes that were associated with DRD2, glutamate, and calcium. DRD2 is a dopamine receptor, and is targeted by the current antipsychotic medications that are available. Glutamate is an excitatory chemical in the brain, and has been hypothesized to be a leading cause of schizophrenia. Calcium is a component in voltage-dependent channels in the nervous system, which have been previously associated with schizophrenia. The results of this study contribute genetic evidence to leading hypotheses on schizophrenia's causes, and show that many different genes and gene products could increase the risk of the disorder.

Another study, conducted by researchers at the Washington University School of Medicine, found that rather than one particular gene dictating the varied symptoms associated with schizophrenia, there are groups of genes that together predict increased risk of schizophrenia. Based on their preliminary results, the researchers found that they could group the schizophrenic subjects into eight distinct categories based on their genetics. Judging by its symptoms, schizophrenia seems like a smattering of practically unrelated conditions. Yet this study demonstrated that schizophrenia's distinct categories of symptoms do not only make it easier to interpret the disease, but are present at the genetic level. According to Dr. Dragan Svrakic, an investigator on the study: "When one study would identify an association, no one else could replicate it. What was missing was the idea

that these genes don't act independently. They work in concert to disrupt the brain's structure and function, and that results in the illness."

These studies have enormous implications for schizophrenia treatment and care. Further research could provide tailored treatment options to individuals depending on which symptoms they exhibit. Medications targeted at specific genes and gene products are also an option, and could help reduce the negative side effects of current medications, encouraging people to remain on their prescriptions.

“FURTHER RESEARCH COULD PROVIDE TAILORED TREATMENT OPTIONS TO INDIVIDUALS DEPENDING ON WHICH SYMPTOMS THEY EXHIBIT.”

Improved treatment for schizophrenia could also increase public knowledge about the disease. According to surveys conducted by the National Alliance on Mental Illness, more than half of people in the United States view individuals with schizophrenia as potentially violent, even though very few people suffering from schizophrenia engage in violent behaviors. Between 70-80 percent of people surveyed said that they would feel uncomfortable dating, working with, or simply being around someone who has schizophrenia and is not undergoing treatment. However, a far smaller percentage (only between 20-30 percent) would still feel uncomfortable being with a schizophrenic who is undergoing treatment.

Public perceptions of mental illness, including schizophrenia, are often misguided, but they can be improved. Recent research indicates that better and more targeted treatment options for schizophrenia are on the horizon. Better medications and improved understanding of the disease would benefit those suffering from schizophrenia, and could improve how society views people who are afflicted. Schizophrenia is a complex disorder, but scientific advancements could bring us closer to eradicating "the voices" that plague far too many individuals today. ■



CLIMATE CHANGE IS AFFECTING OUR SEAFOOD, TOO

MAYA GILCHRIST, ENVIRONMENTAL SCIENCE, 2018

It is no surprise that climate change is at the forefront of today's most pressing issues, concerning scientists and policymakers alike. Recently, approximately 400,000 people from all across the United States marched in solidarity down the streets of New York City to demand action to counter global climate change in the People's Climate March. World leaders have held numerous referendums to attempt to address this issue. For many, the actual impacts of our climate's changing composition may seem like a distant issue. However, as it turns out, the earth's warming temperatures are beginning to affect life in more ways than we may think. Detrimental to marine processes and life, climate change may be responsible for what is—or, more importantly, what is not—on our dinner plates in the future.

In 2013, 36 gigatons of carbon dioxide were released into the atmosphere as a byproduct of human industries, especially the burning of fossil fuels. Since 1990, there has been a 61 percent increase in emissions, meeting humanity's record high. The effects that these emissions have on our air quality and on our atmosphere may be astounding. Yet what is not as widely discussed are the effects on ocean acidification, and the impacts that carbon dioxide emissions are having on the quality of our oceans and all the marine life that resides within it. While the majority of carbon dioxide emitted makes its way into the atmosphere, over 25 percent of it is absorbed in the world's oceans. In the past, this process has been crucial to the normal reduction of atmospheric warming, but there is only so much that the oceans can handle before crossing its threshold.

When water absorbs carbon dioxide, the gas is dissolved, leaving carbonic acid as a product of its reaction. Increasing levels of carbonic acid lead to greater overall acidity in the water. Seawater is naturally basic, but its pH has been creeping towards the neutral and acidic end of the spectrum. Currently, the average pH of the earth's oceans is 8.1, which is 0.1 units lower, or more acidic, than that of pre-industrial times. It is projected to decrease by another 0.5 units by the end of the twenty first century. This may not seem like much, but to the many marine species that depend on very specific circumstances to survive, this difference could be severe.

Smaller life forms are the first to be hit by the negative impacts. A 2010 study found that there was an inverse relationship between carbon dioxide levels and levels of dimethylsulfide (DMS), a byproduct of phytoplankton production. With higher levels of carbon dioxide in the water, fewer phytoplankton are produced. This can be attributed to decreasing amounts of nutrients at the surface of the water. Despite their small body mass, fluctuations in phytoplankton populations could have tremendous repercussions on the oceanic ecosystems as a whole. As phytoplankton are at the base of the marine food chain, biological production is projected to decrease accordingly in all ocean regions. According to the scientists leading the study, "ocean acidification is a driver for substantial change in ocean ecosystems this century, potentially leading to long-term shifts in species composition."

"WHILE THE MAJORITY OF CARBON DIOXIDE EMITTED MAKES ITS WAY INTO THE ATMOSPHERE, A SIGNIFICANT AMOUNT- OVER 25 PERCENT- IS ABSORBED BY THE WORLD'S OCEANS"

However, larger species are also directly impacted by the ocean's increasing acidity. A 2013 study examined the sensitivities of five different marine taxa to ocean acidification. Based on predictions for future acidity levels, negative impacts were predicted for all five taxa: corals, echinoderms, mollusks, crustaceans, and fishes. While crustaceans and fishes were found to be the most resilient, the first three taxa were especially impacted by the acidity due to the calciferous nature of their protective shells. These shells are worn down by acidic waters, and their growth is stunted by the dramatically increased presence of carbonic acid.

These negative effects have already been seen in the 2007 mass death of oyster larvae in Netarts Bay, Oregon. The Whiskey Creek Shellfish Hatchery is the state's leading center for oyster production. Pipes leading in from the bay feed this hatchery, one of the largest

in the nation. Hence, when the larvae suddenly began dying, researchers looked at the source of incoming water. However, a few years later, scientists at Oregon State University were able to pinpoint the problem elsewhere: ocean acidification. Oyster larvae make their shells from calcium carbonate, by capturing carbonate and bicarbonate ions in the water and combining them with calcium ions. Acidification of the ocean has reduced the number of available ions, cutting the number of carbonate ions present in the water by roughly 16 percent. As a result, the oyster larvae find it much more difficult to gather enough ions to build their shells in time and often die.

Ocean acidification effects have yet to cause alarm to East Coast aquaculture industries, but they are not safe from harm's way. Sarah Cooley, a marine scientist at the Woods Hole Oceanographic Institute, estimates that the East Coast has only a few decades before it starts feeling the effects of acidification.

So what does this mean for us? While we in the United States may not feel the other effects of climate change for quite a bit of time, our fisheries and aquaculture are being impacted today. If carbon dioxide emissions are not reduced, the kinds of food we are so used to eating, like seafood, may not be there for us in the future. ■



MISSING A LINK

NATASHA MATHUR, BEHAVIORAL NEUROSCIENCE, 2018

After almost 28 years spent on the shelf in a laboratory, two new species were discovered that may be vital to the understanding of taxonomy. These new species are *Dendrogramma enigmatica* and *Dendrogramma discoides*, and both were discovered in 1986. The specimens were preserved in formaldehyde, washed in water, and stored in 80 percent ethanol before being shelved and forgotten. They were recently rediscovered and gained scientists' attention for their distinctly mushroom-like shape, despite the fact that they were harvested by a research cruise from the ocean off of Australia.

"THESE ORGANISMS WERE LEFT IN A LABORATORY FOR ALMOST THREE DECADES AND NOBODY SUSPECTED THEIR IMPORTANCE"

When a new organism is discovered that resembles a known organism, it is normal to compare the two and wonder if they are similar on the genotypic level, rather than solely the phenotypic. Though these organisms are mushroom-shaped at first glance, they are not fungi at all. Rather, they are multicellular, eukaryotic Metazoans—belonging to the same taxonomic kingdom as all multicellular animals, including humans.

Often, a key item to look out for in classification is whether an organism is symmetrical or not, because it then falls under the category of Bilateria. Many animals fall under this category because of the vertical symmetry seen in their body plan. However, the new organisms are not symmetrical, and are therefore not considered to be Bilateria. They appear to have diverged from the majority of Metazoans prior to the evolution of bilateral symmetry. Although similar to both Cnidaria, the phylum which includes jellyfish, corals, and sea anemones, and Ctenophora, or comb jellies, the samples of these mushroom-shaped animals do not fulfill the criteria to be categorized as either. The organisms show no sign of being torn from the ocean floor, suggesting they were free-floating; yet, neither appear to have been able to swim or propel themselves.

These organisms were left in a laboratory for almost three decades, and nobody suspected their importance. Because the samples were preserved with formaldehyde before being left in ethanol for so long, there is no way to now sequence their genetic code. Now that the researchers know the classification of these two species, they are doing their best to gain more knowledge about them. The co-author of a paper written on the two species, Dr. Olesen, stated, "We published this paper in part as a cry for help." So far, he believes that the organisms could be "a very early branch on the tree of life, or be intermediate between two different animal phyla," leaving a lot of blank spaces that need to be filled in to complete this picture.

The biggest question regarding these new species is: where do they fit in our current understanding of the development of species? It is difficult for scientists to understand a species without making assumptions based on its classification. The best way to identify and classify these organisms without bias is via genetic testing of the DNA. The only possible option left in this situation is to discover more samples in order to fully understand how these underwater samples have derived from the organisms we already know. Sequenced organisms can be compared against each other to find similarities and differences, giving a clear picture of how related they are.

Without genomic support, a claim like this is very susceptible to being questioned and even ridiculed. Dr. Olesen and his team are hoping for similar samples to arise elsewhere in the world so that the classification of these mysterious ocean mushrooms can be narrowed down. Until the samples are classified, people will be left wondering what these organisms mean to the big picture, and what this missing link may mean for taxonomists. Until more samples can be collected, scientists can't be sure. ■



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