

***Sonorensis***  
ARIZONA-SONORA DESERT MUSEUM

**One Health:**  
*Healthy Desert Healthy People*





2021

# Sonorensis

ARIZONA-SONORA DESERT MUSEUM

Volume 40, Number 1  
2021

The Arizona-Sonora Desert Museum  
Co-founded in 1952 by  
Arthur N. Pack and William H. Carr

Craig Ivanyi  
Executive Director

Debra Colodner  
Director, Conservation Education  
and Science, Editor

Martina Clary  
Design and Production

*Sonorensis* is published as a benefit to the Arizona-Sonora Desert Museum membership as a resource for furthering understanding of the Sonoran Desert Region. 2021 N. Kinney Road, Tucson, Arizona 85743. ©2021 by the Arizona-Sonora Desert Museum, Inc. All rights reserved. No material may be reproduced in whole or in part without prior written permission by the publisher.

Visit us at [www.desertmuseum.org](http://www.desertmuseum.org)

Cover: Hiker enjoying the view from Treasure Loop Trail in the Superstition Mountains.

Back cover: Panorama of Saguaro National Park West.

We gratefully acknowledge all the authors, translators, photographers, and organizations who contributed articles, photos, or maps for this issue of *Sonorensis*.



# ONE HEALTH:

Healthy Desert, Healthy People

## T A B L E O F C O N T E N T S

**1-5**

One Health

*Debra Colodner*

*Director of Conservation Education and Science*

**6-11**

Fire and Buffelgrass

*Kim Franklin, Conservation Science Manager*

**12-19**

Tucson Bee Collaborative

*Kim Franklin, Conservation Science Manager*

**20-25**

Foods for Hotter Drier World

*Jesus Garcia, Associate Research Scientist*

**26-33**

Nature and Health

*G. Marie Swanson, Founding Dean, Mel and Enid Zuckerman*

*College of Public Health and Desert Museum Docent*





Panoramic sunrise in Phoenix, Arizona

# ONE HEALTH

**Debra Colodner, Ph.D.**, Director of Conservation Education and Science

The connections between human health, animal health, and environmental health (known as “One Health”) entered the mainstream of public awareness in the past 2 years. As of this writing, we still don’t know the exact origins of SARS-CoV-2, but scientists suspect that the source was a bat, which may have transmitted the virus through an intermediary host animal. For many people in the US, it may have been the first time we heard of some of these possible hosts (such as horseshoe bats, pangolins, ferret-badgers or civets) but they are an important part of ecosystems, food systems and trade in Africa and Asia. We learned that not only might animals pass the disease to humans, but that people can transmit the coronavirus to animals. Big cats and great apes in our

zoos caught the disease from people, as did minks on farms. As we battle toward the holy grail of “herd immunity”, our word choice recognizes that we too are animals. At the time of this writing, we have lost more than 5 million of our herd to the coronavirus, and health agencies are calling for “new” approaches to prevent the next pandemic.

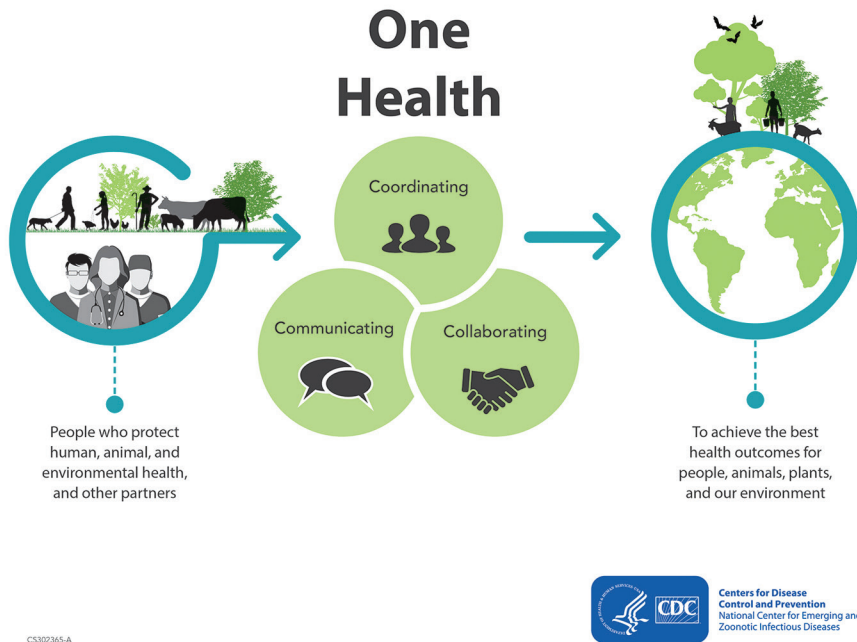
One Health is an integrative approach to health that emphasizes the links among human, animal and environmental health. It is not a new concept, but it is getting renewed attention due to the coronavirus pandemic. The term “One Health” was first used about two decades ago, but traditional knowledge holders have lived by this paradigm for millennia. One Health approaches are increasingly

important as the impact of human activities on the environment expands. One Health gets physicians talking with veterinarians, ecologists, social scientists, educators, farmers, ranchers and cultural experts. It offers a useful frame in which to view the relationship between people and the rest of nature, when the goal is to improve overall health.

## **UN PANEL SAYS CONDITIONS ARE WORSENING FOR SPILLOVER**

A 2020 report of the UN Intergovernmental Platform on Biodiversity and Ecosystem Services, an independent secretariat connected to the United Nations Environment Programme (Workshop on Biodiversity and Pandemics), noted





that the conditions that favor the emergence of pandemics are becoming more widespread. These include rapid land-use change, agricultural expansion and intensification, and wildlife trade and consumption. These activities disrupt the natural functioning of ecosystems, including the interactions among wildlife and their microbes, and increase contact among people, livestock, wildlife and their pathogens. Climate change also affects the spread of disease by changing the geographic range of microbes and their hosts.

Land-use change is thought to be responsible for about 30% of the emergence of new diseases in humans since 1960. Conservation of protected areas and measures that reduce unsustainable exploitation of high biodiversity regions will reduce the wildlife-livestock-human interface and help prevent the spillover of novel pathogens. Human health impacts are often not considered when land-use decisions are made, but should be a key future consideration, whether converting lands for human use or restoring ecological function.

Mounting evidence from the past decade shows that protecting the biodiversity of a region reduces the emergence and transmission of diseases to people. On the other hand, regions that are naturally very high in biodiversity,

such as tropical forests, can also serve as a source of new pathogens. Forest clearing and fragmentation for farming or ranching increase contact between people and wild animals. Animal viruses may jump to people directly when they handle live wild animals or their meat, or may be passed through farm animals that were previously infected by wild animals. Humans and livestock are more likely to contact wildlife when more than 25% of the original forest cover is lost.

Another pathway for pandemic emergence is through trade in wildlife. The Association of Zoos and Aquariums, the accrediting body for the Desert Museum, supports the Global Initiative to End Wildlife Crime, a global effort of businesses and non-governmental organizations. This initiative takes a One Health approach by bringing together experts in human, wildlife and environmental health, and proposes amendments to current international agreements to include human health in decisions on the regulation of wildlife trade. Although some people advocate banning wildlife trade and consumption all-together, the Global Initiative to End Wildlife Crime proposals acknowledge that millions of people depend on wildlife for sustainable nutrition and livelihood, with little risk of promoting pandemics. The Initiative instead

“ONE HEALTH IS AN APPROACH THAT RECOGNIZES THAT THE HEALTH OF PEOPLE IS CLOSELY CONNECTED TO THE HEALTH OF ANIMALS AND OUR SHARED ENVIRONMENT.”

-Centers for Disease Control



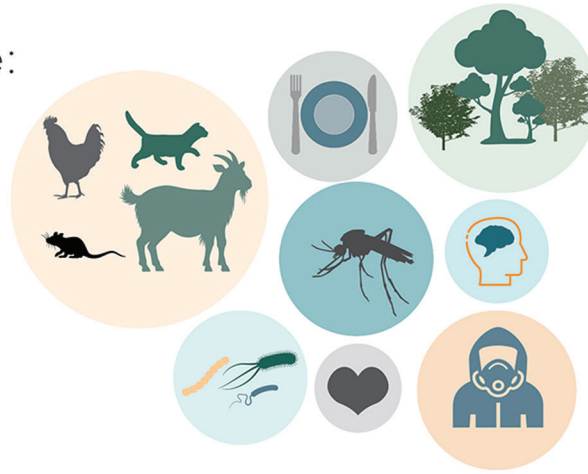


## Did You Know?

**One Health** issues include:

- Zoonotic diseases
- Antibiotic resistance
- Food safety and security
- Vector-borne diseases
- Environmental health
- Chronic diseases
- Mental health
- Occupational health

...And more!



[www.cdc.gov/onehealth](http://www.cdc.gov/onehealth)



Deer mouse

proposes that international law and enforcement should target specific places and practices where a threat exists to public health and/or biodiversity. The initiative also calls for economic aid to mitigate the impacts on communities.

### ONE HEALTH IS NOT JUST FOR PANDEMICS

One Health approaches are being applied to a wide range of issues that impact human health, such as zoonotic disease (disease that is transmitted from animals to humans), food safety, environmental contamination, and the emergence of antibiotic resistance. As discussed in *The Arizona-Sonora Nature Spa*, later in this issue, mental health, occupational health and chronic disease treatment can also benefit from collaborative One Health strategies that recognize the need for communication and collaboration among sectors and communities that used to operate in separate spheres.

### HANTAVIRUS CASE STUDY

Hantavirus is a disease with complex environmental-animal-social connections. It was first recognized in Korea in the 1950s, and hundreds of thousands of people in East Asia are infected each year. Hantavirus cardiopulmonary

syndrome was first diagnosed in the Americas in the 1990s, but it was later discovered that the virus had been in the US since 1959. The Sin Nombre strain of hantavirus was identified as the cause of a sudden and mysterious outbreak of cardiopulmonary disease on the Navajo Nation in 1993. Most cases in the US continue to be in the Four Corners Region at the intersection of Utah, Colorado, Arizona and New Mexico, but hantavirus has popped up in 36 states.

The outbreak was the result of the complex cycles of climate, vegetation, and rodent populations. The winter before the outbreak was an El Niño period, when unusually warm water in the eastern Pacific Ocean caused an unusually wet winter in the southwest US. Ample rains supported flourishing plant and insect populations: a windfall for rodents. Rodent populations were 20 times higher than normal that year. Epidemiologists found that people who became infected were more likely to have more rodents around their homes and were more likely to have done clean-up work around their homes than people who did

not develop the disease. Further study confirmed that people become infected by breathing dust containing dried rodent feces, urine or saliva. Thirteen people died during this outbreak, 50% of those infected!

Thankfully, hantavirus remains rare. Only 728 cases occurred in the US between 1993 and 2017. The One Health approach to preventing this disease includes monitoring climate and vegetation responses in order to prepare for possible outbreaks, adapting land use and housing planning to limit contact with rodents, and public education in vulnerable communities about wearing masks during high-risk activities.

### CHAGAS DISEASE CASE STUDY

Another example of One Health in practice is the Kissing Bug Project conducted by the University of Arizona Health Sciences. Kissing bugs are known to transmit Chagas disease, which is prevalent in Latin America, but still rare in the United States. As many as 8-11 million people in Latin America are infected annually, most of whom do not know they have the disease. About 20-30% of people develop chronic symptoms, and







Mosquito



Longhorn bees



Big Brown Bat

if left untreated, Chagas disease can be life-threatening. It is especially present in poor rural communities. Human infection occurs due to contact with the fecal matter of the kissing bug. A bitten person unknowingly scratches or rubs the bite area, picking up a bit of bug poop on their fingers, and rubbing it into the open bite, or transferring it to their eyes, nose or mouth.

Kissing bugs and the Chagas parasite interact with other mammals as well. The bugs will typically feed on blood from a wide variety of wild animals, such as rodents, frogs, snakes, and coyotes, and around human populations, will feed on domestic animals and people. Wild and pet dogs are an important reservoir of the disease and are thought to get infected with the parasite by either licking the site of a bite or eating infected insects or rodents.

Campaigns to reduce Chagas disease in Latin America have focused on increased surveillance in people, improvements in housing, and indoor insecticide spraying. Several US states have reported cases acquired locally, including Texas, California, Louisiana, Mississippi and Tennessee, but not yet Arizona. The Kissing Bug study at the UA is collecting bugs, testing people who have been bitten by kissing

bugs and their pets, and studying the environment around homes where bugs have been found inside, in order to determine the risk factors for bites and infections. For more information, and to learn how you can participate, see <https://kissingbug.medicine.arizona.edu/chagas-disease>.

#### HOW ANIMALS HELP HUMANS STAY HEALTHY

Although the focus at the moment is preventing the transmission of potential pandemic viruses from animals to humans, animals also help prevent disease. They help keep disease vectors (such as mosquitos and rodents) in check, and they often serve as the proverbial “canaries in the coal mine,” sentinels of disease outbreaks or environmental contamination. For example, dead birds were used to monitor for West Nile virus as it spread across the US. In another example, a die-off of birds in Western Australia alerted authorities to a contaminant in the air, which turned out to be lead carbonate dust from a nearby mine. This led to the discovery of lead contamination in home water sources, and solutions that prevented long-term lead exposure in people. Animals are also often used as models to understand the effects of environmental pollutants.

#### BATS ARE NOT THE ENEMY

Bats are an important reservoir of many of the viruses we are concerned with today, but they are not to blame for the increase in pandemic risk. Changes in our own behaviors are bringing us into closer contact with bats. Bats are more likely to feed near human settlements when their forest habitats are disrupted. Bats are also key allies in the fight against many infectious diseases transmitted by night-flying insects, such as mosquitoes. Other bats eat nectar and pollen and are important pollinators and maintainers of biodiversity. (Bats pollinate the agaves from which we coax mescals, such as tequila, which may have contributed to a few happy moments during the pandemic.)

In North America, hibernating bats are suffering their own pandemic, white nose syndrome, which is spread by humans. The disease is caused by a fungus that was inadvertently brought to New York from Europe by hikers or cavers in 2006. It's been spreading westward in the US and Canada since then, killing millions of bats. Bats in Eurasia are well adapted to resist this fungus, and it does not cause disease there. In 2016, the disease showed up in Washington state, and the fungus has now been detected in northern California. In the Eastern US, many caves have been closed,

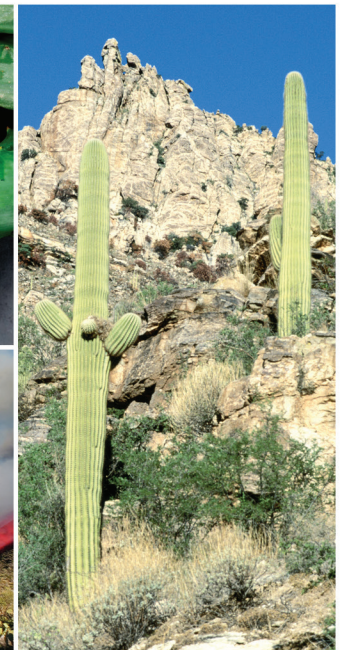




Blue Agave



Bighorn Fire, Santa Catalina Mountains



and cave researchers must follow strict decontamination procedures. Due to the scarcity of the disease in the western US, western states have been slower to take these precautions. It has not yet been detected in Arizona.

### ONE HEALTH PERSPECTIVES & PRESCRIPTIONS

The fungus that causes white nose syndrome is just one example of the many microbes and toxic substances human activities have introduced and/or spread around the planet. Understanding the effects of these pathogens and chemicals on human and wildlife health requires an integrative, holistic One Health approach.

The One Health approach requires increasing communication and coordination across cultural, geographical and disciplinary boundaries. Recent concern about increasing risks of pandemic emergence has led to new levels of much needed coordination among international organizations concerned with human health, agriculture, farmed animal health, wildlife health, and environmental quality.

A recent study in the journal *Science* (Dobson and colleagues, 2020) estimated that the cost of protecting tropical forests through direct payments is far less than the cost of

responding to pandemics. Conservation of these areas, including continued sustainable use by Indigenous people, is predicted to lead to a 40% reduction in the risk of pandemic virus spillover. They estimate that the funding needed to protect forests (paying authorities to conserve ecosystem function and protect Indigenous land rights) is about \$9.6 billion annually (US dollars). Combined with other preventive costs, such as monitoring wildlife trade, early detection and control, and monitoring livestock, the total costs of prevention would be \$22 - \$32 billion annually. Compare this to the costs and losses of battling a pandemic in the tens of trillions.

The University of Arizona recently established a One Health research initiative housed within the Mel and Enid Zuckerman College of Public Health. It aims to address complex disease systems by identifying and studying linkages among human, animal and environmental health. Its new lead, Professor Frank von Hippel, says, “The program will increase collaboration among faculty and community partners from formerly disparate fields to inform public policy and public health practice.”

In this issue of *Sonorensis*, we draw connections between the Desert Museum’s conservation work and public health

and well-being. In *Weeds, Fires, and the Future of the Sonoran Desert*, Kim Franklin updates us on work to control the spread of fire-prone buffelgrass, and the importance of this work for maintaining air quality and biodiversity, both necessary for our ability to enjoy nature. Few things are more important to health than food, and Kim Franklin and Jesus Garcia provide an update on partnerships to monitor local pollinators and develop the potential of native plants and future food crops in *Bees and Biophilia* and *Foods for a Hotter, Drier World*. In the final article, *The Arizona-Sonora Nature Spa*, G. Marie Swanson reflects on the health effects of nature, through the perspective of a visit to the Desert Museum.

Elizabeth Mrema, Executive Secretary of the UN Convention on Biodiversity, summed up the global value of One Health as follows: “Conserving and restoring ecosystems can prevent further degradation and will abate the conditions of the emergence of other infectious diseases. The One Health approach will not only promote sustainable health and just recovery from the COVID-19 pandemic, but it will also serve broader health objectives beyond the absence of diseases. It will equally strengthen the resilience of social, ecological and economic ecosystems.”<sup>8</sup>





# Weeds, Fires AND THE FUTURE OF THE *Sonoran Desert*

BY KIM FRANKLIN, PH.D.

## INTRODUCING...THE *Weeds*

In the 1960s a new grass species started popping up in the Tucson Metropolitan Area, which then harbored only a quarter of today's human population. Few took notice of this newcomer, but botanists stationed at the Desert Laboratory on Tumamoc Hill collected several specimens and deposited them in the University of Arizona Herbarium. The newcomer was buffelgrass (*Cenchrus ciliaris*), a fast-growing and reproducing bunchgrass native to Africa and southern Asia, widely introduced into the southwestern U.S. to feed cattle and control erosion.

Buffelgrass was one of several species declared to be "miracle grasses" by scientists working to restore rangelands degraded by decades of overgrazing and drought around the turn of the twentieth century. Another of these miracle grasses was Lehmann's lovegrass (*Eragrostis lehmanniana*), a perennial bunchgrass native to southern Africa. Both were brought to the Soil Conservation Service Plant Materials Center in Tucson in the 1930s, and planted widely throughout southern Arizona and Sonora over the next three decades. Since then, they have both proven to be highly invasive species in the Sonoran Desert.



Buffelgrass and Lehmann's lovegrass are warm-season perennial grasses, germinating with any rainfall that arrives when temperatures are warm enough. As perennials, individual plants may live for many years. Plants become dormant as conditions dry out, persisting on the landscape in this dormant and flammable state most of the year.

In addition to warm-season perennials, many cool-season annual grass species have also proven to be highly invasive and fire-prone. Among the worst of these is red brome (*Bromus rubens*), which germinates in the spring, especially after wet winters, and then dies back in the arid foresummer (the warm months before monsoon season). Unlike our miracle grasses, red brome, a native to southern Europe, arrived in the Southwest via accidental introduction, well before the arrival of buffelgrass and Lehmann's lovegrass.

### THE WEED *invasion*

All three of these species have been wildly successful here in the Sonoran Desert, where they outcompete our native plants for limited resources – space, water and nutrients. All three of these grasses use water very efficiently. For example, red brome germinates in the fall with any rainfall event of at least half an inch, giving it a head start on our spring wildflowers (eg. poppies, *Eschscholtzia Mexicana*; lupines, *Lupinus sparsiflorus*), whose germination requires at least one inch of rain in the fall, followed by regularly spaced rains throughout the winter. As perennials, buffelgrass and Lehmann's lovegrass have the advantage that they are present in the landscape throughout the year, whether in an active or dormant state, essentially saving their seat at the table. Where buffelgrass and Lehmann's lovegrass grow thick, there are no spring or summer wildflowers regardless of whether it's a wet or dry year.

Limited by freezing temperatures, buffelgrass is largely confined to the lower elevation desert, where it fills in the empty space between shrubs, trees and cacti. With time, even these larger, woody and succulent species succumb, and what was once a richly diverse desert converts to flammable grassland. Our iconic and long-lived saguaros may persist longer than any other native plant species on the buffelgrass-invaded

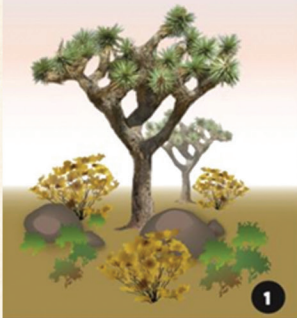
Left photo: Invasive buffelgrass growing wild on a rocky outcrop in Pima Canyon. Right photo: Saguaro National Park.



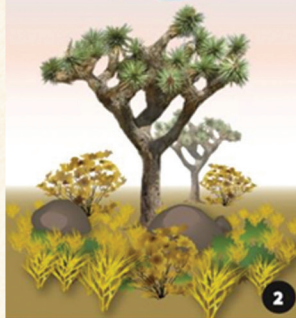




Desert scrub with little or no fuel connectivity and no evolved adaptation to fire.



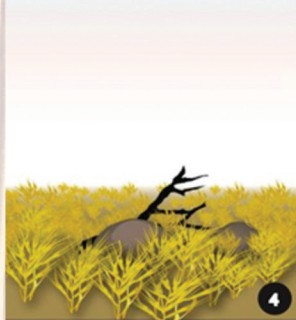
Invasion by non-native grass connects shrubs and trees.



Fire kills native shrubs and trees.



After the fire, non-native grasses recover more rapidly than native species.



Infested area burns repeatedly.

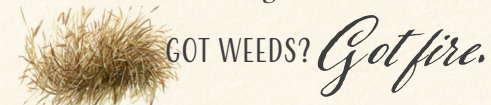


In a matter of years to decades, fireproof desert is converted to flammable grassland.



bajadas in the Tucson Basin, but their days are numbered. As this “grassification intensifies,” saguaro recruitment and survivorship gradually decline due to competition and wildfires.

Red brome, like buffelgrass, favors desert habitat, but exerts its greatest impact after wet winters. Two consecutive wet winters set the stage for explosive population growth. The seed produced in the first winter germinates in the second winter to produce a bumper crop of green grass, which turns to tinder-dry fuel during the arid foresummer. In contrast to buffelgrass and red brome, Lehmann’s lovegrass thrives at slightly higher elevations, reducing the abundance and diversity of native plants in our desert grasslands. At the transition between desert to grassland, there is a mix of buffelgrass and Lehmann’s lovegrass.



All three of these invasive species are excellent fuel for wildfire. While fire is healthy component of grassland ecosystems, fire is new in the Arizona Upland subdivision of the Sonoran Desert, the favored habitat of buffelgrass and red brome. The Arizona Upland plants are what most locals think of as classic “Sonoran Desert” – saguaro, prickly pear, and cholla cacti, ironwood and palo verde trees, with various shrubs such as creosote, jojoba and ocotillo. Historically, fires in Arizona Upland took place only when annual plants boomed after wet periods, and even then, fires were mild and patchy. Consequently, many if not most native plant species in this subdivision of the Sonoran Desert are poorly adapted to withstand fire, especially the high-intensity fires fueled by buffelgrass. In experimental burns, buffelgrass fire temperatures were recorded at 1300 to 1600°F, versus 190 to 750°F recorded in wildfires fueled by desert annual plants. This is largely due to the greater fuel load in buffelgrass-invaded landscapes, which is thousands of times greater than typical Sonoran Desert fuel loads.

The spread of these invasive grass species, among many others, is changing fire regimes in the Sonoran Desert and in western North America more broadly. Each of these three species is not only excellent fuel for fire, but thrives on fire, creating a positive feedback loop or grass-fire cycle – grass invades, promoting more frequent fire, which in turn promotes further grass invasion, and even more frequent fire. This change in fire regime spells doom for many if not most of our native desert species.

Upper left: Joshua Tree National Park. Lower left: Burned Joshua tree after the Dome Fire in Mojave National Preserve in August 2020. Illustration of the invasive grass fire cycle by Jeanne DiLeo-Stevens.





For what feels like a long time, some in our community have been warning of an impending catastrophe, a wildfire of unprecedented size and severity in Tucson's wildland-urban interface, where housing developments push up against wildlands that have been invaded by fire-loving buffelgrass. When a wildfire ignited on the southwestern flanks of the Santa Catalinas on June 5th 2020, those of us involved in the effort to combat buffelgrass feared the worst. The south slopes of the Santa Catalina Mountains, where buffelgrass took root some forty years ago, now harbor some of the largest, densest stands of buffelgrass in the Sonoran Desert.

The Bighorn fire burned for over seven weeks, engulfing nearly 120,000 acres, but the south slopes of the Santa Catalinas, were largely spared, thanks to the tremendous work of our firefighters, cutting fire breaks, conducting back burns, and laying retardant. Their valiant efforts combined with the patchy distribution of buffelgrass near its upper elevation limit and favorable winds, limited the spread of the fire into the desert. Moreover, we were lucky that the ignition took place in the grassland above the desert and prevailing winds and natural firebreaks kept the fire from descending into the densest buffelgrass stands in the canyons below and to the east of the ignition point. The Catalina Foothills wildland-urban interface, with many neighborhoods forced to evacuate for the first time ever, dodged the bullet.

The Bighorn Fire was a near miss in the Catalina Foothills, but it gave Tucson and other Arizona communities a glimpse of a fiery future, a future that has already become the norm in communities across the West. In the U.S. in the past 20 years, wildfires have burned well over twice as much land area per year than those from the last twenty years of the twentieth century. Climate change, decades of fire suppression in forested ecosystems accustomed to frequent low intensity fire, and an increase in human ignitions are all contributing to this increase in annual area burned, but until recently, invasive grasses had been overlooked. Last year colleagues from the University of Massachusetts Amherst examined the impact of invasive grass invasions on fire occurrence in the lower 48 states, finding that in nearly every region of the country, invasive grasses are altering fire regimes. In the case of buffelgrass, fire occurrence tripled in invaded areas.

2020 was a record-setting year for fire across the West. Arizona saw its second largest wildfire season on record with nearly one million acres burned, surpassed only by 2011, the year of the massive Wallow Fire. Moreover, much of this fire took place in desert and semi-desert



photo by Paul Mirocha



photo courtesy of National Park Service



photo by Marilyn Hanson



Top: View of the Santa Catalinas from the top of Tumamoc Hill. Middle left: Herbicide application in Saguaro National Park. Middle right: Doug Siegel, Pima County Natural Resource Specialist applies herbicide on slopes above Starr Pass. Bottom: Bighorn Fire in the Santa Catalinas





photo courtesy Arizona Daily Star



grasslands, driven by the wet winters of 2018 and 2019, which led to an abundance of fine fuels, including red brome and other invasive grasses. While the Bighorn Fire was burning in Tucson, the Bush Fire, the fifth largest fire in Arizona history, was burning through Sonoran Desert up through high elevation forests just north of Phoenix, eventually consuming nearly 200,000 acres. Later that summer the Superstition Fire burned through nearly 10,000 acres of desert and semi-desert grassland threatening Apache Junction and nearby towns.

### DON'T INHALE: *wildfires* AND *human health*

How will an increase in the frequency, size, and severity of fires impact life in the Sonoran Desert? Evacuations significantly interrupt people's lives. For those in the path of the fire, the trauma that results from fleeing in the face of the fast-moving flames or returning home to a pile of ash can have long-lasting impacts on physical, mental, and financial health.

Air pollution generation by wildfire affects a much larger swath of the population. The massive amount of smoke and ash generated by the wildfires in California in 2020 blocked the sun from the sky, turning day into night. Smoke is a complex mixture of gasses and particles. Most of the research has focused on fine particulate matter, tiny particles less than 2.5 microns in diameter, otherwise known as PM2.5. To provide some perspective, this is 30 times smaller than the width of a human hair. The smaller the particle, the deeper it can penetrate into the lungs, with adverse effects on the respiratory and immune systems.

Another air pollutant generated by wildfire is ground-level ozone, the main component of smog. When vegetation burns it releases two of the key components for the formation of ground-level ozone, which has many of the same adverse health effect of fine particulate matter including inflammation and damage to the respiratory system. Although air pollution has generally decreased in recent decades in the U.S. due to increased regulation, wildfire emissions have been increasing, and can impact areas thousands of miles away. Last summer Tucson exceeded the EPA's limits on ground-level ozone eight times.

### SAVING OUR *saguaros*

The destruction to the natural environment may be the impact most difficult to quantify. In August 2020 the Dome Fire, fueled in large part by red brome, burned through 44,000 acres of the world's

Upper left: Buffelgrass fire on A Mountain July 4, 2017; Upper right: Buffelgrass resprouting in August 2017; Middle left: Burned saguaros one week post-fire; Middle right: Burned saguaros in field of green buffelgrass one month post-fire; Bottom: Burn scar on A Mountain shortly after fire.



largest Joshua tree forest in Mojave National Monument. Substitute saguaro forest for Joshua tree forest to get a sense of what we stand to lose in the Tucson Basin, home to some of the densest stands of saguaros in the world. What would the loss of saguaros mean for our well-being? Saguaros are synonymous with Sonoran Desert; they are the reason so many visitors choose to come here, rather than some other warm sunny winter destination, and thus a pillar of our economy. Saguaros are a keystone species, supporting an exceptional diversity of insects, reptiles, birds, and mammals that depend on them for food and shelter. The Tohono O'odham consider saguaros to be their ancestors, who have cared for this land since time immemorial.

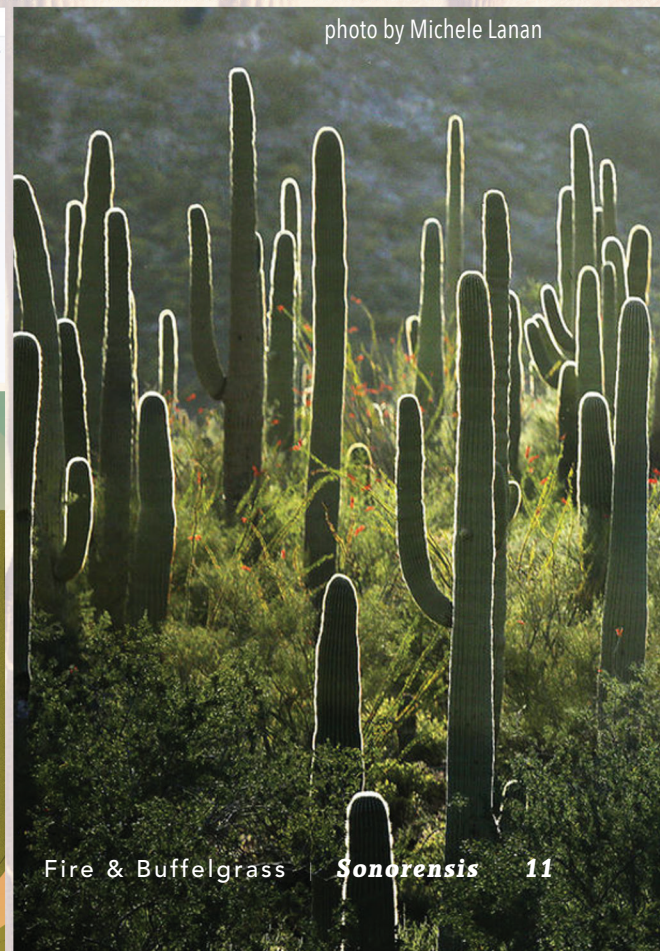
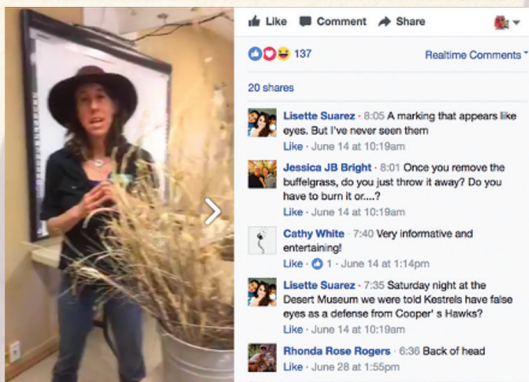
The Bighorn Fire gave us the opportunity to study the behavior of fire at the edge of the buffelgrass invasion, on the south slopes of the Santa Catalinas, and the opportunity to learn how we might preserve as much as possible of the exceptional biodiversity in this landscape. Perhaps the most important lesson learned is that even relatively small fire breaks can be effective in preventing the spread of the fire. Creating fire breaks and access points for our firefighters could help limit the extent of damage in future fires, which are inevitable. These are exactly the type of actions funded by the Southern Arizona Forest Fund, which has just launched a campaign to fund efforts to map the buffelgrass infestation on the south slopes of the Santa Catalinas and restore some of the areas hardest hit by the fire. We also have the opportunity to contain the buffelgrass invasion by treating its leading edges. Colleagues and I are working to educate communities along Arizona State Route 77, north of Oracle, which sits along one of these leading edges.

This type of work takes sustained commitment from the highest levels of government as well as local communities most impacted by wild-fire. It takes close coordination across jurisdictions, between agencies and levels of government. It also takes commitment from the public. No group has demonstrated more commitment than the Sonoran Desert Weedwackers, who head to the Tucson Mountains every other week to dig up buffelgrass. Thanks to their tireless effort, a drive over Gates Pass today is just as beautiful as it was 50 years ago. It can be done!

To learn more and to support these efforts, please visit the Desert Museum's buffelgrass website and the Southern Arizona Forest Fund. [S](#)

*Kim Franklin is the Science Program Manager at the Arizona-Sonora Desert Museum.*

Top: Diverse annual wildflowers, such as those in the foreground, are often out-competed by buffelgrass; Middle and bottom left: Buffelgrass outreach and education; Bottom right: Saguaro "forest."





A close-up photograph of a green and yellow fuzzy bee on a red flower. The bee is positioned on the left side of the frame, facing right. It has a green thorax and abdomen with yellow stripes, and its legs are covered in fine hairs. The background is a soft, out-of-focus gradient of red and orange, suggesting a flower. The title 'Bees & BIOPHILIA' is overlaid on the right side of the image in a large, yellow, sans-serif font.

# Bees & BIOPHILIA

By Kim Franklin, Ph.D.

Photos by Bruce Taubert,  
unless otherwise noted. Bruce is a Conservation Photographer  
who is working with scientists to document  
Arizona's diverse and beautiful bees.





Left photo: *Agapostemon* sp.; *Xylocopa varipuncta*; *Centris pallida* male; *Centris rhodopus* female. Cut out below: The author's children.

## BEES

As a scientist who studies bees and the mother of two young children, I occasionally find myself in the field with two enthusiastic little helpers. Collecting bees is an activity they enjoy immensely. They are fascinated by these tiny creatures. My five year old knows more about bees than I did, even in college. She knows that they come in many different sizes, shapes and colors, and that the ubiquitous, but non-native, honey bee is just one variety. She knows they can nest in holes in the ground, or in agave stalks or even wooden beams, and that most of them won't sting. My eight year old can understand that when bees visit flowers, they are performing an essential service to plants, transferring the pollen they need to reproduce. He knows who to thank for his favorite fruits.

For me, I see a bigger picture: bees are essential workers in maintaining the biodiversity and overall health of our natural and agricultural ecosystems. Watching and learning about bees has helped all of us feel more connected to nature and less fearful of even its stingy parts. For me, I also know that this new knowledge will help us protect biodiversity into the future. This is the vision of the Tucson Bee Collaborative: connecting people to nature and to each other through bees.

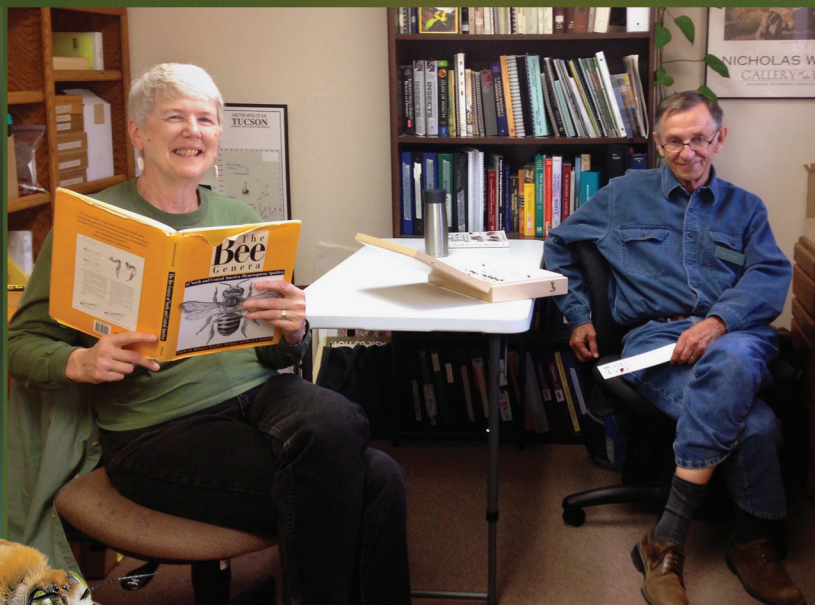
At its core, the Tucson Bee Collaborative is a partnership among scientists, students, teachers, artists, and a diversity of volunteers, to better understand our regional bee diversity, and through that process, to offer opportunities to connect with nature in meaningful ways. Bees are not only an important component of our biodiversity, but a group both widely revered and feared.

Everyone has seen a honey bee, a domesticated species now found on all continents except Antarctica, but few have taken time to look for

our incredible diversity of wild bees. In fact, there are more species of bees in the Sonoran Desert than just about anywhere else in the world. Most Tucsonans would be hard pressed to name even one of the hundreds of native bee species found here. They include the tiny *Perdita minima*, which is less than 0.08 inches (2 mm), to the large carpenter bees (genus *Xylocopa*), gentle giants that can have body lengths of almost 1.5 inches (40 mm). Some sport the classic black and yellow, but others are shades of grey, black, brown, or even metallic green, with textures from fuzzy to shiny.







Above, left to right: Bees sleeping in a flower; Volunteer scientists, Olga and Buzz; Bee emerging from nest. Right photo: *Agapostemon* spp.

We live in one of the richest places in the world in terms of number of bee species, yet our bees are poorly known and certainly underappreciated. This might seem to be a sorry state of affairs, but from another perspective, this lack of knowledge presents an exciting opportunity to engage the community in the process of documenting and describing the exceptional bee diversity of our city. And that is something the Tucson Bee Collaborative aims to do.

At the Desert Museum work starts with systematically collecting bees, work that is carried out by a team of indefatigable Desert Museum volunteers. We have established three long-term monitoring sites, which we sample with pan traps: small blue, white, and yellow cups attractive to bees. Our first traps were set in February 2019, and since then we've been setting traps in

each site, every two weeks, never missing a sample, a testament to the dedication of these volunteers. The result is a total of nearly 12,000 bees!

But we are just getting started. We plan to monitor the bee populations in these sites for many years, perhaps even decades to come. Long-term data is critical to understanding the health of bee populations, which can fluctuate wildly among years. In many ways, native bees are like the seeds of our annual wildflowers. They can lie in a state of dormancy in the soil for many years, waiting for a signal that the flowers they depend upon for food will be in bloom. Their survival depends upon emerging from their underground nests only when conditions are just right.

For example, in just two years of sampling, we have observed dramatic differences in the abundance and diversity of bees in our three

long-term monitoring sites. In 2020 Tucson experienced its hottest and second driest summer on record. As you might expect, we found fewer bees in the summer and fall of 2020 than in the same time period in 2019.

This quantitative, long-term monitoring program is critical to understanding bee populations in the Tucson Basin. But this isn't the only data we are using to document the diversity of bees in our region. We are inviting everyone to contribute by sharing their bee observations on iNaturalist (<https://www.inaturalist.org/projects/tucson-bee-collaborative?tab=about>), a social media platform for sharing observations of not just bees, but all species big enough to photograph. Already the public, perhaps even one of you reading this article, have contributed more than 8,000 observations of bees and



WE LIVE IN ONE OF THE RICHEST  
PLACES IN THE WORLD IN TERMS  
OF NUMBER OF BEE SPECIES,  
YET OUR BEES ARE POORLY KNOWN  
AND CERTAINLY  
UNDERAPPRECIATED.

the insects associated with them. Participating not only provides people with opportunities to connect with nature, another aim of the Tucson Bee Collaborative, but helps us understand to diversity of bees throughout the region.

One of the most significant hurdles to long-term monitoring projects is accurate species identification. Collecting a single bee from a pan trap (or a flower) might take you a matter of seconds. Determining which species you collected might take days, or even weeks of careful study. That is to say, bees are not easy to identify! In fact, identification of many, if not most bees requires the expertise and experience of a scientist who has dedicated years to studying bees. Only a handful of such scientists exist.

The Tucson Bee Collaborative grew out of a collaboration between scientists at the Univer-

sity of Arizona Insect Collection and biotech students at Pima Community College to tackle this identification hurdle. Over the past two decades, new molecular identification tools have been developed. One of those tools is DNA barcoding, a tool with a remarkable number of applications.

DNA barcoding is a system of species identification that relies on sequencing a short stretch of DNA. For animals, that sequence is the cytochrome oxidase 1 gene (CO1). In most cases, this sequence will be identical in individuals of the same species, and differ in individuals of different species. It's like the system of product identi-



...IDENTIFICATION  
OF MANY, IF NOT MOST BEES  
REQUIRES THE EXPERTISE  
AND EXPERIENCE OF A SCIENTIST WHO  
HAS DEDICATED YEARS TO  
STUDYING BEES.





...STUDENTS' WORK IS CREATING

A RESOURCE

FOR SCIENTISTS TO IDENTIFY AND UNDERSTAND

THE DIVERSITY OF BEES NOW AND INTO THE FUTURE.





Left photo: Longhorn bee sleeping on stem; Above, left to right: Mother bee returning to nest with pollen; Bumble bee; Oil-foraging *Centris* bee on *Krameria* bush.

fication found in any supermarket. Just as we can scan the barcode of an item on the shelf to identify the product, we can scan the sequence of the CO1 gene from an unidentified specimen to identify the bee.

The Tucson Bee Collaborative works with students at Pima Community College, under the supervision of Jennifer Katcher, faculty member in the Division of Sciences, to prepare DNA samples for barcoding. Students obtain a bee leg and extract its DNA. Then the CO1 gene is copied many times using a technique called polymerase chain reaction. This produces a sample large enough to measure, which is then sent to a facility for DNA sequencing. Students compare their bee's DNA sequence to other sequences in the international Barcode of Life Database. Sometimes students find a match and are able to identify the bee species. Often there is no matching DNA sequence

because nobody has studied the DNA of their particular bee. That means that the student is able to contribute the first sequence of that bee in the database. The students' work is creating a resource for scientists to identify and understand the diversity of bees now and into the future. With guidance from Dr. Wendy Moore, Director of the University of Arizona Insect Collection, Pima College students have published 78 bee DNA sequences, or "barcodes," including 28 DNA sequences that were new to science!

After DNA extraction, the bee specimen goes to the UArizona Insect Collection to be part of the largest known collection of Sonoran Desert bees. Natural history collections such as this one are an archive of species diversity across space and time, and can be studied to assess the impact of environmental change on biodiversity. For example, using nearly one mil-

lion records of bees and other pollinators from natural history museums, researchers uncovered significant declines in bees in Britain and the Netherlands since the 1980s. Each specimen, and its associated data, also has value individually, providing a snapshot of a particular species at a particular time and location. Moreover, new technology is allowing us to unlock new information from historical specimens, for example, enabling us to sequence the DNA of specimens hundreds to even thousands of years old.

By collecting photographs and bee specimens in the field, and extracting and reading their DNA barcodes in the lab, the Tucson Bee Collaborative helps to connect people to nature and to each other through bees. Bees may be small, but they are among the easiest wild animals to observe up close. You'll find them almost anywhere you find flowers. We in





photo by Glenn Seplak

photo by Glenn Seplak

Above, left to right: Bumble bee; *Centris*, male; *Centris*, female; Right photo: *Diadasia rinconis* in a cactus flower.

vite you to participate this spring, by submitting a photograph of a bee in your neighborhood to iNaturalist. As long as you are within the Sonoran Desert Region, your observation will become part of the Tucson Bee Collaborative iNaturalist project. Your observation will help us better understand the diversity of bees.

## BIOPHILIA, THE LOVE OF NATURE

Watching my kids and other young students in nature bears out what the health sciences are confirming: nature is good for us. In the 1980s famed biologist E.O. Wilson was exploring human relationships to nature and the concept of “biophilia,” a term first used by the philosopher Erich Fromm to describe an attraction to living

things. Wilson further developed this concept, proposing that humans have an innate desire to connect with nature as well as an innate propensity to learn about nature.

Attraction to (biophilia) and fear of (biophobia) living things are both fundamental connections to nature that likely stem from the thousands of years of evolution through which humans struggled to survive. Survival required rapid learning about both resources and threats.

At the time that Wilson was exploring the concept of biophilia, there was little research on how connection to nature impacts human health, but in recent decades the literature on this topic has exploded. Evidence that connection to nature is an essential piece of our well-being is growing rapidly. More and more studies are showing that even short bouts of nature, such as gazing up at a

tree for a few minutes, benefits our physical (e.g. lowers blood pressure), emotional (e.g. relieves depression) and mental (e.g. improves cognitive function) health in many ways. (See “The Nature Spa”, this issue)

As you get out to get your nature fix, I hope this peek into the world of bees has helped to increase appreciation and reduce fear of these essential buzzy bodies. They help maintain the magnificent biodiversity of our urban and wild landscapes, as well as our food supply. If you’d like to get involved or simply learn more, check out the Tucson Bee Collaborative at [www.tucson-beecollaborative.com](http://www.tucson-beecollaborative.com). ■

*Kim Franklin is the Science Program Manager at the Arizona-Sonora Desert Museum*





EVIDENCE  
THAT CONNECTION TO NATURE  
IS AN ESSENTIAL PIECE  
OF OUR WELL-BEING  
IS GROWING RAPIDLY.





# FOODS FOR A HOTTER DRIER WORLD

BY JESÚS MANUEL GARFÍA

I'm glad I'm wearing a face mask; this time it's doing double duty as I work in a cloud of mesquite flour dust. I grab a piece of rope to tighten a cloth skirt over the basket that is filling with fragrant flour from the semi-industrial hammer mill. We are grinding a half dozen different kinds of *péchitas* (mesquite beans) while keeping the mandated social distance from each other.

We are running the new mill for the first time at Oatman Flats Ranch, an organic farm experimenting with heritage and arid-adapted crops on the Lower Gila River, west of Gila Bend. As the beans from several different trees are milled, we taste the flour of each one with anticipation; we know the beans are delicious, but the grinding transforms the flavor even further. Some are classic mesquite, some taste lemony, some sweet, some buttery. As our palates rejoice with these unique flavors, almost in unison we agree, we have to grow this one!

We are here today, tasting mesquite, as an outgrowth of a project I have been involved with over the past two decades: the Kino Heritage Fruit Trees Project. This effort focuses on the study and reproduction of naturalized Mediterranean fruit crops and vegetables that have played important roles in the history and culture of northern Sonora and southern Arizona. By experimenting with these plants, we have developed horticultural techniques to preserve favored varieties of fruit trees and vegetable crops. By combining traditional and modern propagation and growing techniques, many people, especially Tucsonans, are embracing history and heritage through these revived plants that provide cherished foods.

The "Kino trees" are well-adapted to a historical Mediterranean climate, but what about the hotter, drier climate predicted for our region in the future? Our experiences with the "Kino trees" have led us to take a similar





Mesquite beans and products: flour, roasted beans, and jelly.

approach with native Sonoran Desert plants, like mesquite.

As we venture into the summer months of 2021 the headlines confirm what most Tucsonans already know. Records have been broken on many fronts: heat, drought, wildfires, economic and food insecurity, just to mention the obvious ones. According to the National Weather Service, hotter and drier than normal conditions will persist through early summer, due to a La Niña climate pattern. Added to the warming trend we've seen over the last few decades, the need for crops better adapted to these conditions is apparent.

### LOOKING FOR FOODS FOR THE FUTURE IN THE PAST

In the New World, the cultivation of crops began in our own "fertile crescent" known as Mesoamerica. It is an ecologically, culturally, and agriculturally diverse

region located in southern Mexico and Central America. To this day, the so-called Mesoamerican diet, or pre-Colombian diet, persists in this region.

In contrast, arid northern Mexico and southwestern US were presumed to lack both diversity and abundance of food. In Mexico the region is known as La Gran Chichimeca, a cultural region inhabited by several tribes of semi-nomadic Nahua people, including the Aztecs, and most other tribes of northern Mexico. In recent years, ethnobotanist and ethnographer Gary Paul Nabhan and anthropologists A. L. Kroeber and Paul Kirchhoff coined the term "Aridamerica" to describe the vast region north of Mesoamerica. This new term takes into consideration the geographical, ecological and cultural aspects of the region.

In the face of climatic uncertainties, farmers, gardeners, orchardists and conservation ecologists are looking to the past for wisdom about how to grow food. As





Above clockwise: The author between rows of agave & prickly pear; prickly pear lemonade; two prickly pear nopalera; nopal lemon smoothie; results from a brix test for sugar in saguaro fruit; green tea with prickly pear fruit.

in Mesoamerica, the peoples of Aridamerica adapted their practices to their ecological surroundings and adapted their lifestyles to the ecological demands. They also domesticated numerous wild arid-adapted crops, including greens, grains, legumes, cacti, fruits, and several species of agaves. New studies on the wild-relatives of crops have revealed that the existing ecological and genetic biodiversity of wild and domesticated species in the deserts of Aridamerica are worthy of our attention.

**In Growing Food in a Hotter, Drier Land: Lessons from Desert Farmers on Adapting to Climate Uncertainty** Nabhan, presents many examples of agricultural practices from the past that are relevant today. Although this book was published almost a decade ago, Bill McKibben's review is still true: "If there was ever a moment for this book, now is it."

In a more recent publication (*An Aridamerican Model for Agriculture in a Hotter, Water-Scarce World, Plants, People, Planet, 2020*), Nabhan, I and other colleagues call for a dramatic paradigm shift to move desert food production in the opposite direction from the high-input annual cropping systems that are now struggling worldwide. This new perspective can help us see our desert with different eyes, as a laboratory for the future of agriculture.

### PRICKLY PEAR: FUTURE SUPERFOOD?

Most Tucsonans are very familiar with the local prickly pear cactus, nopal del monte (*Opuntia engelmannii*), which is found wild all around the Tucson basin and foothills. Less common here are varieties of *Opuntia ficus indica*, which are



**NEW STUDIES** ON THE  
WILD-RELATIVES OF CROPS  
HAVE **REVEALED** THAT THE  
EXISTING ECOLOGICAL AND  
**GENETIC BIODIVERSITY**  
OF **WILD AND DOMESTICATED**  
SPECIES IN THE DESERTS OF **ARID AMERICA** ARE  
**WORTHY OF OUR ATTENTION.**



very different in flavor, size, shape and number of spines. They are found in many backyards of Hispanic families, especially in older houses, and occasionally they can also be found on road medians.

Over the last few years, Gary Nabhan and I became interested in exploring the benefits of *O. ficus indica* as a regional food source. We connected with a colleague at the National Arid Land Plant Genetic Resource Unit in Parlier, California, a maintenance unit of the National Plant Germplasm System in California. We were able to obtain a dozen or so varieties of this cactus pear, also known as *nopal de castilla* in Spanish. These specimens have been added to a collection including another dozen or so varieties I have collected over the years in the Tucson area and Southern Arizona.

This collection is now growing at the Mission Garden, where we will pay close attention to growth and development of the plants and fruits in coming years. In addition to producing *nopalitos* (edible tender pads) these varieties have incredibly diverse fruits, known as *tunas* in Spanish, and prickly pear fruit or cactus pear in English. Many of these specimens are already producing delicious fruit and the future is promising. The diversity of flavors, textures and colors have endeared me to this arid-adapted crop.

In addition to this growing diversity of prickly pear, we have started a collection of agave plants that also hold great potential as cultivated arid-adapted crops. I have a personal connection to agaves. My father was a *mezcalero* (a mezcal distiller). He was born and raised in the Sonoran River





WE LOOK FORWARD TO **SHARING** ALL  
THESE **SUSTAINABLE,**  
**HEALTHY FLAVORS** OF PRICKLY PEAR,  
AGAVE AND MESQUITE **WITH** THE  
**COMMUNITY** IN THE NEAR FUTURE  
THROUGH **WORKSHOPS** AND DEMONSTRATION  
GARDENS AT THE **MISSION GARDEN** AND AT  
**THE DESERT MUSEUM.**

Valley and grew up working in the mountains, making clandestine mezcal bacanora (a regional mezcal from Sonora) with his uncle. As I grew up in Magdalena, Sonora and occasionally visited the Rio Sonora region, I was immersed in my father's stories of his life as a young alchemist hiding in the mountains. His detailed descriptions of harvesting and roasting wild agaves, and fermenting and processing the spirits have always been with me.

My interest in the diversity of agaves has only increased over the years. Through my travels to southern Mexico, reading academic studies, and getting to know agave gurus, such as Wendy Hodgson (at the Desert Botanical Garden) and Suzanne and Paul Fish (from the Arizona State Museum and Anthropology Department at the University of Arizona), I have learned much

about the diversity and cultural legacy of this Árbol de las Maravillas. This tree of wonders doesn't only have deep roots in Mesoamerica, but also along the northern fringes of Aridamerica. Agave scholars have identified more than 200 species of agaves in the Americas, about a third of which have been domesticated for various purposes: food, fermented drinks, syrups, fibers, etc. Here, in southern Arizona, scientists have identified close to a dozen varieties associated with human cultivation.

In the last decade, botanists at the Arizona-Sonora Desert Museum have been growing and experimenting with several anthropogenic agave species, including *Agave murpheyi*, *A. palmeri*, *A. perryi*, *A. scabra* and *A. Americana*. Most of these species exhibit unique characteristics of domestica-





Above clockwise: Blue agave field in Tequila, Jalisco, Mexico; tequila with lime and salt; map of Aridamerica; Brix test mission grapes; harvested agave hearts; roasted agave Mission Garden; a variety of prickly pear fruit.

tion, such as reproducing asexually via rhizomes (pups that sprout from the roots) or bulbils (plantlets that grow on the flower stalk), making them relatively easy to cultivate.

As we savor our success growing and reproducing cacti and agaves, we are now setting our sights on leguminous trees (trees with long seed pods that open along seams on two sides) such as mesquite, paloverde and ironwood. But not every legume is created equal. This brings us back to the grinding of mesquite at Oatman Flats Ranch. Coming in and out of the cloud of flour dust, my friend Aaron M. Wright, a preservation archaeologist collaborating with the ranch, keeps bringing in different mesquite beans to grind. We can imagine tasting this wonderful tapestry of flavors as cookies, crack-

ers, bread, and even tortillas or atole (a hot corn- and masa-based beverage), all enhanced by local mesquites. We look forward to sharing all these sustainable, healthy flavors of prickly pear, agave and mesquite with the community in the near future through workshops and demonstration gardens at the Mission Garden and at the Desert Museum.

Jesús Manuel García is a Research Associate, Arizona-Sonora Desert Museum and founding board member of the Friends of Tucson's Birthplace, Mission Garden. **S**





Saguaro National Park



Pin cushion cactus



Desert tortoise

By G. MARIE SWANSON, PH.D.

# the Arizona-Sonora Nature Spa

If you know Tucson, you know that we are world-famous for health spas - resorts designed to enhance our physical and emotional health. Have you ever thought of the Arizona-Sonora Desert Museum as a spa? As a retired public health professional, I can tell you that I do. It is a nature spa!

The purpose of this article is to identify and explore the public health benefits of zoos in general, and the Desert Museum in particular. Studies carried out around the world have shown that spending at least five hours a week immersed in nature (including the managed nature of parks, zoos, gardens, etc.) produces consistent improvement in health, defined by the World Health Organization as "...a complete state of physical, mental and

social well-being." Time in nature improves cognition, relaxation, intellectual functioning and reduces stress.

Have you ever thought about how you feel physically and mentally before and after your visit to the Museum? As you drive over Gates Pass or other approaches, just looking around at the saguaro forest jump-starts your experience. I usually find myself in high spirits and feeling energetic during and after my visits. The Desert Museum is somewhat unique among zoos and botanical gardens in that it is both, offering traditional zoo exhibits of animals from the Sonoran Desert, and extensive botanical gardens. The result is a place that allows us to fully immerse ourselves in the Sonoran Desert. This experience is really good for us.

Whether you are healthy, or struggling with an injury or illness, a visit to the Museum can be a very positive component of your therapy. Many years





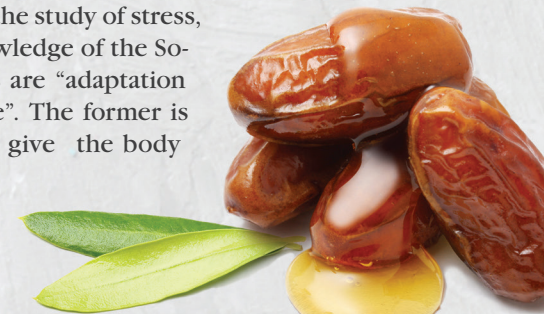
ago, my husband was in a wheelchair due to a complex of chronic illnesses. We visited ASDM at least once a week and he was a different person after these visits. He loved the hummingbird aviary, so I would take him there, park him in his favorite spot inside the aviary, and go wander around the grounds for an hour or two. When I returned, he always was full of great stories about hummingbird antics, and had a very big smile on his face. Now, even though he has been gone for 18 years, I still see and hear his joy every time I go into the aviary.

This is a personal example of what research is finding. Visiting zoos and interacting with the animals improves mood, fosters creativity, and ultimately improves our overall health. Our connection to nature and its benefits for human health is a relatively new field of research. Studies range from a focus on the general benefits of our connections to wilderness, to specific effects of plants and wild animals, to the health benefits of visits to zoos. Our connection with nature has a holistic impact on our health, producing positive effects for our bodies, our minds, and our spirits.

## CHILL-OUT WITH *nature*

Let's start with a brief discussion of stress and positive approaches to stress reduction. In the mid-1950s, Hans Selye began extensive research on stress, its sources, its effects on our mental and physical health, and positive ways to adapt to, or reduce stress. The Sonoran Desert, and thus the Desert Museum, is a good place to learn about such adaptation, as here we see animals and plants with extensive and effective adaptations to many sources of stress.

Selye developed important concepts in the study of stress, and they too have resonance with our knowledge of the Sonoran Desert. Two of Selye's key concepts are "adaptation energy" and "general adaptation syndrome". The former is protective, and functions during stress to give the body its capacity to adapt to and overcome stressors. The latter refers to the body's accumulation of adaptive changes to stressors. These concepts are useful in this







discussion of the desert generally, and the Museum specifically, as an effective resource for adaptation to human stressors.

Just as Sonoran Desert animals and plants are adapted to the stresses of extreme heat and aridity, human adaptations to stress enable us to thrive during the many demanding periods of our lifetimes. Living amidst the many stressors of today's pandemic requires us to use much of our adaptation energy and to find effective adaptive resources. A visit to the Desert Museum takes us away from the stressors of social restrictions. It also is an excellent opportunity to be outdoors, thus providing relief from having to spend a much larger portion of our lives indoors. By interacting with the Museum's residents, both animal and botanical, we can engage in a very productive form of meditation—focusing entirely on a specific mammal, bird or cactus.

Major advances in the understanding of human stress, and our ability to adapt to it, were made by Aaron Antonovsky in the late 1970s through the 1980s. He introduced a concept that he called “salutogenesis”, which referred to the sources of health, rather than the sources of illness. This term was proposed as the opposite of pathogenesis as the primary approach to understanding human health. Antonovsky saw health and disease as a continuum, from a state of health to a state of disease. In public health, we focus on establishing and maintaining health as the primary approach to understanding human health.

Antonovsky also developed the concept of “sense of coherence” to describe the way in which humans establish control over their physical and mental environment, thus enabling us to adapt to and overcome many stressors. Ultimately, this sense of coherence is one factor that enables our immune systems to reduce the biologic and mental effects of stress. Today's research into the positive health effects of nature, of interacting with animals, and spending time in zoos and gardens is, at one level, an extension of this early research into human stress and our responses to it. The time we spend in nature very clearly fits Antonovsky's





definition of a “generalized resistance resource, or ”any characteristic...that can facilitate effective tension management.”

Spending time in nature makes us feel happier—through connecting with other species, through escaping our daily worries, through sheer enjoyment. As we relax and our stresses melt away, our bodies and minds experience great benefits. Connecting with nature reduces levels of the primary stress hormone, cortisol. At normal levels, cortisol has benefits such as enhancing the brain’s use of glucose and improving tissue repair. At increased levels, cortisol can reduce energy, block the healing capacity of our bodies, or lead to mood swings and impair mental health. As we relax, cortisol levels decline and return to healthy levels. Thus, your walk around the Museum, with all of your senses immersed in the Sonoran Desert, has the potential to improve your health.

Moving on to cutting edge research today, one key area of neuroscience research focuses on the effects of various forms of human connections with nature and the functions of the human brain. These studies show that time spent in natural environments improves memory, enhances creativity, helps

to control emotions and improves overall mental and physical health. Already, doctors practicing integrated medical approaches are prescribing time in nature, through programs such as Park Rx. This will certainly improve our ability to maintain health, and provide benefits for the treatment of mental and physical health issues.

## *one* HEALTH

Today’s research into the understanding of human health and our connection to nature is being advanced in an emerging health discipline—One Health, defined as “...the collaboration across disciplines to improve the health of humans, animals, and the environment.” Research into







the health benefits of zoos is an important area of focus for One Health scientists. (See “Biodiversity and One Health,” this issue.)

Current research on visits to zoos and their impact on human health shows that a single visit can lower blood pressure, reduce stress, and improve mood. Just walking for several hours and being outdoors in a stimulating environment is clearly good for us. Escaping from the bonds of our everyday high tech environment will clear our heads and strengthen our bodies.

The One Health perspective also includes specific human interactions with the natural environment, including those with plants and trees. Two excellent books are *The Biophilia Effect* and *The Nature Fix* (see references, below). These are great examples of current neuroscience research into the connection between nature and specific functions of human brain.



## VIEW FROM *abroad*

People around the world have recognized the connection between nature and health. Japan and South Korea have established forest therapy trails and healing forests with a new forest ranger specialty - the health forest ranger. Studies have shown that time spent in forests strengthens the human immune system, as well as improving mood, reducing blood pressure and restoring tranquility.

In Finland, research has shown that just five hours a month spent in parks and forests produces positive health effects. In Scotland and Sweden, programs in ecotherapy and horticulture therapy address a range of health concerns, from stress to depression. In Scotland, outdoor mental health therapy programs target a variety of illnesses, including addiction. In Sweden, mental health treatment programs include gardening to improve focus and achieve mindfulness.

You don't have to go abroad to participate in these more structured programs. Tucson Botanical Garden has been offering Horticultural Therapy since 1983!





## A LIFE-LONG NEED FOR *nature*

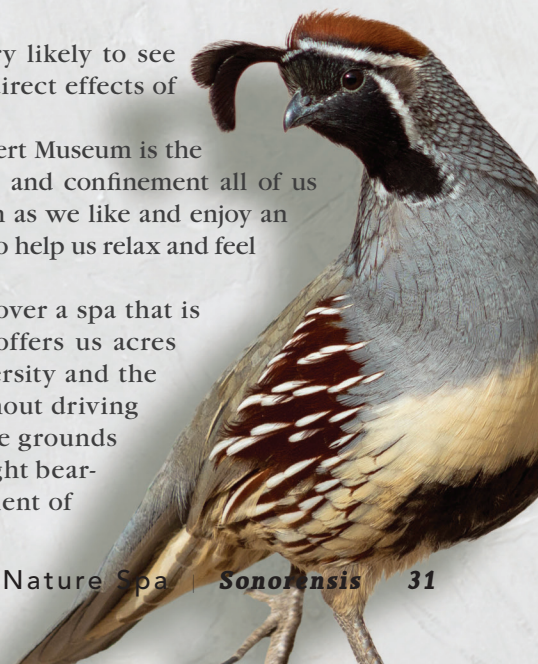
The difference between my childhood, over 50 years ago, and today's childhood experiences is vast. My "play" time was 80% outdoors. Today's children are usually superglued to their technology, whether the phone, computer or tablet. They see more "outdoors" and nature electronically than live. My air was cleaner, and the stream that ran behind our home was clearer than air and water today. The research and education carried out by the Desert Museum and other zoos will contribute to improving the quality of air and water for the future, in great part by preserving and enhancing biodiversity.

As zoos conduct more research in the areas of ecology and conservation, they contribute not only to the quality of human life, but also the quantity. Stress alone (see Selye) is well known to reduce both the quality of life and individual and population life span. When we study the effects of today's pandemic in the ensuing years, we certainly will see a variety of negative impacts

upon our quality of life. We are also very likely to see reductions in longevity well beyond the direct effects of COVID-19 itself.

Right now, during a pandemic, the Desert Museum is the perfect place for respite from the stresses and confinement all of us are experiencing. We can go there as often as we like and enjoy an intriguing environment that is guaranteed to help us relax and feel good about ourselves and the world.

This nature spa has a huge advantage over a spa that is confined indoors. The Desert Museum offers us acres of grounds on which to explore the diversity and the beauty of the whole Sonoran Desert without driving across Arizona and Mexico. A walk on the grounds is physical activity of the best kind—weight bearing—and also offers the social enhancement of sharing the experience with family







and friends. By focusing on what the animals are up to or how the plants look, we escape more stressful thoughts on which our minds have been dwelling. This is a form of meditation which takes us away from our worries, which are many more than usual during this pandemic. We can meditate by immersing ourselves in a favorite spot, or imagining travel to more distant reaches of the Sonoran Desert. Travels of the mind are an excellent option, while physical travel is so restricted.

HO, HO-A *boojum!*

My favorite example of the happy surprises I've found at the Museum is the reaction of a 5 year old

to the boojum tree. If you're not familiar with the boojum (it's native to Baja California and one place in Sonora), it looks like a huge upside-down green carrot, right out of the pages of a Dr. Seuss landscape. When the young guest asked me what it was, I told him, "It's a boojum." He loved that word so much he went running to his father, saying, "Dad, Dad, let's name our dog Boojum." He and his dad thought that would be a fine name for a dog.

Each of us will have our own unique reaction to the magical species we find on the Desert Museum grounds. As a new Museum Docent whose volunteer contributions were cut very short by the pandemic, and as a public health academic and epidemiologist, I can tell you that my visits to the Museum these days are a major contributor to my physical and mental well-being, and my happiness. We know that laughter is good for you! Here is my prescription: visit the Desert Museum and laugh at the antics of the animals, the strangeness of some plants, and the joy of humans as we interact with each other and our natural world. 📌





## REFERENCES AND SUGGESTED READINGS

- Aaron Antonovsky, **Health, Stress and Coping**, San Francisco, Jossey-Bass, 1979.
- Clemens G Arvay, **The Biophilia Effect**, Boulder, CO, Sounds True, 2018.
- Margarita Artschwager Kay, **Healing with Plants in the American and Mexican West**, Tucson AZ, The University of Arizona Press, 1996.
- Robin Wall Kimmerer, **Braiding Sweetgrass**, Minneapolis MN, Milkweed Editions, 2013.
- Richard Louv, **Last Child in the Woods**, Chapel Hill NC. Algonquin Books of Chapel Hill, 2005.
- Park Rx, [parkrxamerica.org/about](http://parkrxamerica.org/about)
- Michael Pollan, **The Botany of Desire**, New York, NY. Random House, 2002.
- Hans Selye, **The Stress of Life**, New York, NY. McGraw-Hill, 1956.
- Florence Williams, **the Nature Fix**, WW Norton, 2017.

*G Marie Swanson is Professor and Founding Dean Emerita of The University of Arizona Mel and Enid Zuckerman College of Public Health. She is a Docent at The Desert Museum. Her 40-year career was dedicated to understanding the causes of health disparities in chronic diseases, as well as developing effective approaches to prevention. She received her training in epidemiology at The Johns Hopkins University and is past President of the American College of Epidemiology. Today, she is happily retired in Tucson, and enjoys hiking, living in the beautiful Sonoran Desert, and laughing at the crazy antics of her dog, Guero.*







2021 N. Kinney Rd.  
Tucson, AZ 85743-8918

NON-PROFIT  
ORGANIZATION  
U.S. POSTAGE  
PAID  
ARIZONA-SONORA  
DESERT MUSEUM

