

THE WARBLER

AN EDUCATIONAL WEEKLY

ISSUE

117

JULY 6, 2022

Dear Student, Artist, Thinker, Friend,

The first time I learned about coral reefs was when I watched the movie *Finding Nemo* as a child. Since then, I have always had a fascination with them. They're beautiful, providing a natural display of color. We could even equate them with a painting if we so chose. Coral reefs also hold 25% of the ocean's wild-life, which is almost unfathomable given that they take up such a tiny part of the ocean's space. They're almost like cities in the ocean. Corals themselves are really magnificent creatures. I had no idea they were animals until fairly recently. Do you want to know something interesting? Corals have a living component called a polyp and a skeleton called the calicle. They are technically boneless organisms that are closely related to jellyfish and sea anemones. Corals eat by using their tentacles to grab zooplankton, which are microscopic animals. That's not the only way though! They have a special relationship with algae. The algae uses sunlight to produce sugar, much of which is transferred to the coral. This relationship is known as mutualistic symbiosis. Mutualistic means that both organisms benefit. The algae get a place to live while they are protected while the coral get the nutrients.

Symbiosis is the scientific term surrounding living beings' relationship with each other. Coral reefs are full of symbiotic interactions which is just so cool to me. They act as natural water purifiers which is why the water is almost clear. They also act as a barrier during storms, protecting the people who live on the coastlines next to them. People often think they only live in shallow waters, but that's just not true. They function differently, but they have been found in water temperatures as 39 degrees Fahrenheit and over 6561 feet under the surface. The water pressure that deep in the ocean would kill a human. I may be a biology nerd, but I hope you enjoy reading this week's edition of *The Warbler* as much as I enjoyed helping write it.

Tammy and the APAEP Team

"The coral that grows at the edge of the reef is always the strongest and most colorful because it faces the greatest battering."

HONEYSUCKLE WEEKS // British actress

WORDS INSIDE

FOUND INSIDE "WHAT ARE CORAL REEFS?"

excrete | To separate from the body, expelling

dinoflagellate | A single-celled organism with two flagella or hair like structures

FOUND INSIDE "POEM"

gurnard | A bottom dwelling fish of coastal waters

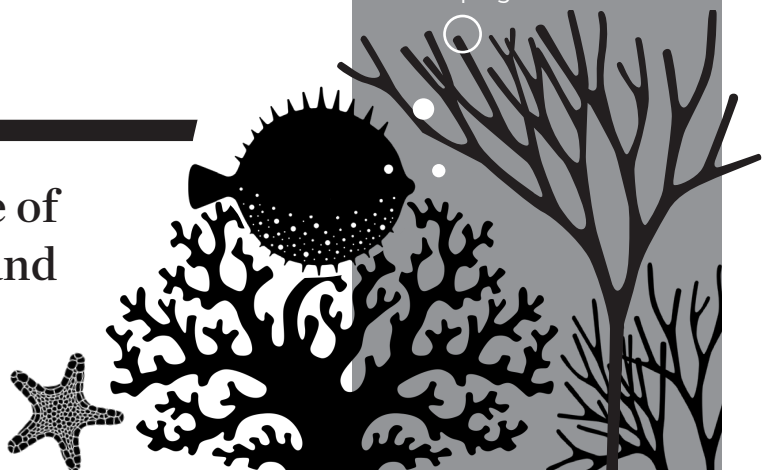
FOUND INSIDE "SCIENTISTS ARE TRYING TO SAVE ..."

symbiotic relationship | Close associations formed between different pairs of species

proverbial | Well-known, especially when thinking stereotypically

FOUND INSIDE "RANDOM NEST"

emergent | The process of coming into being, developing



GEOLOGY

What Are Coral Reefs?

BY JENNIFER KENNEDY | *ThoughtCo* | January 30, 2019

Reefs are centers of biodiversity, where you'll find many types of fish, invertebrates and other marine life. But did you know that coral reefs are also alive?

What Are Coral Reefs?

Before learning how reefs form, it's helpful to define a reef. A coral reef is made up of animals called stony corals. The stony corals are made up of tiny, soft colonial organisms called polyps. Polyps look a lot like a sea anemone, as they are related to these animals. They are invertebrates in the Cnidaria phylum.

In stony corals, the polyp sits within a calyx, or cup that it excretes. This calyx is made of limestone, also known as calcium carbonate. The polyps are interconnected to form a mass of living tissue over the limestone skeleton. This limestone is why these corals are called stony corals.

How Do Reefs Form?

As the polyps live, reproduce, and die, they leave their skeletons behind. A coral reef is built up by layers of these skeletons covered by living polyps. The polyps reproduce either through fragmentation (when a piece breaks off and new polyps form) or sexual reproduction through spawning.

A reef ecosystem may be made up of many species of corals. Healthy reefs are typically colorful, highly biodiverse areas made up of a mishmash of corals and the species that inhabit them, such as fish, sea turtles, and invertebrates such as sponges, shrimp, lobsters, crabs, and seahorses. Soft corals, like sea fans, may be found within a coral reef ecosystem, but do not build reefs themselves.

The corals on a reef are further cemented together by organisms like coralline algae, and physical processes like waves washing sand into spaces in the reef.

Zooxanthellae

In addition to the animals living on and in reefs, the corals themselves host zooxanthellae. Zooxanthellae are single-celled dinoflagellates that conduct photosynthesis. The zooxanthellae use the waste products of the coral during photosynthesis, and the coral can use the nutrients provided by the zooxanthellae during photosynthesis. Most reef-building corals are located in shallow water where they have plenty of access to the sunlight needed for photosynthesis. The

presence of the zooxanthellae helps the reef to thrive and become larger.

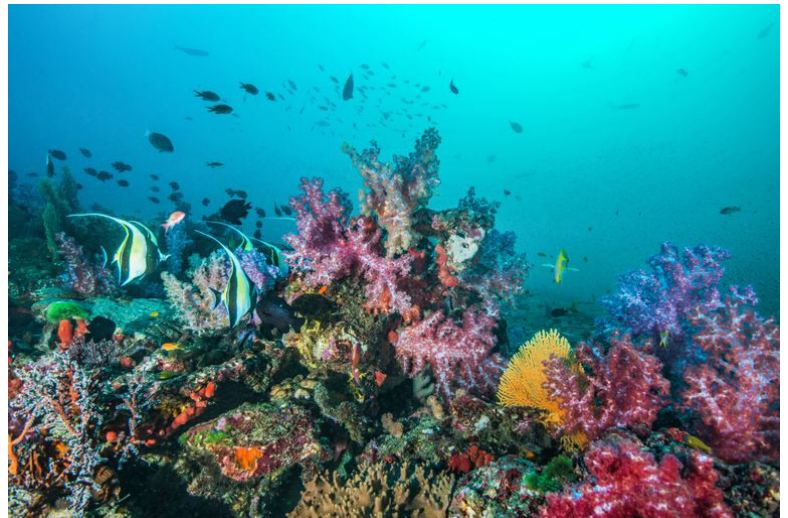
Some coral reefs are very large. The Great Barrier Reef, which stretches more than 1,400 miles off the coast of Australia, is the world's largest reef.

3 Types of Coral Reefs

Fringing reefs: These reefs grow close to the coast in shallow waters.

Barrier reefs: Barrier reefs, like the Great Barrier Reef, are large, continuous reefs. They are separated from land by a lagoon.

Atolls: Atolls are ring-shaped and located near the sea surface. They get their shape from growing on top of underwater islands or inactive volcanoes.



Threats to Reefs

An important part of coral reefs is their calcium carbonate skeleton. If you follow ocean issues, you know that animals with calcium carbonate skeletons are under stress from ocean acidification. Ocean acidification causes a lowering of the ocean's pH, and this makes it difficult for corals and other animals that have calcium carbonate skeletons.

Other threats to reefs include pollution from coastal areas, which can affect reef health, coral bleaching due to warming waters, and damage to corals due to construction and tourism. ●

Kampee Patisena/
Moment/Getty Images

HABITAT

Animals That Live in Coral Reefs

FROM INTERESTINGANIMALFACTS.COM | February 9, 2022

Coral reefs are one of the world's most unique ecosystems, supporting an immense amount of diverse marine life. They are beautiful islands of color and marine activity, and hundreds of unique species and subspecies rely on this ecosystem and its resources for survival. The coral reef, just like any other ecosystem is a delicately balanced system of balances that are constantly influencing each other, as the various creatures that live there fight for survival.

Sea Horses | Sea horses are some of the most unique animals in the world and are famed for their iconic equine silhouette (from which their name is derived) as well as their unique swimming which is unlike any other animal that dwells in the sea.

In fact, sea horses are known to be among the worst swimmers of all the animals in the ocean, which is why they are so reliant on coral reefs and the relative protection and stability they offer sea horses from the endless movement of the ocean, and the predators within it. Seahorses use their tails to hold onto coral reefs, as well as to grab other things, and they feed by sucking small crustaceans and plankton into their trumpet-like snout.

Eels | Eels are a common sight at coral reefs, particularly moray eels, where they find ample hunting grounds and hiding places from which to strike their prey.

The moray eel is the largest species of eel and can be found in shallow waters near reefs. They hide within the crevices of the reef where their considerable size can be concealed quite well, even larger specimens that can grow up to 15 feet in length. They strike by wrapping their prey up and flattening it out with their body until it can be swallowed.

Sharks | Various species of sharks can be seen at coral reefs, from fearsome Great Whites to Hammerheads and even gentle Nurse Sharks.

The abundance of life found at coral reefs makes them an unsurprisingly opportune target for predators such as sharks and provides ample pickings for the aggressive sharks. While bottom feeders like the Nurse Shark have plenty of algae and other debris to feed off of on the sea bottom surrounding the reef.

Puffer Fish | Pufferfish are known for their iconic defense mechanism that makes them an unpleasant target for predators. When attacked, they use their stomach to ingest a vast amount of water very quickly,

causing them to expand in size dramatically (up to three times in size!) with some species even having spikes and spines on their surface to make them an even less appealing meal.

Pufferfish feed on algae and invertebrates which are plentiful around coral reefs, and some pufferfish will even find their way into clams and shellfish.



Rays | They are often hunted as prey by larger species of reef shark such as the grey reef shark, which is notorious for its aggression, as well as the dangerous tiger shark and other smaller species of shark such as white and blacktip sharks on rare occasions.

Rays are known for their large size, as well as their unique method of swimming which often involves them rippling their bodies like giant wings in the water, to propel themselves forward.

Clown Fish | The now-iconic clownfish rose to worldwide fame and popularity after the Pixar movie *Finding Nemo* was released, detailing the plight of two desperate clownfish. They are known for their amazing colors, which are a vivid orange base with white stripes trimmed in black. They are also famous for nesting inside sea anemones, which are toxic to most other fish, as a defense from potential predators.

Turtles | Various species of turtles make their home in and around coral reefs, as they make excellent places to feed and rest, especially after or in between long periods of activity and travel.

Crustaceans | Various species of crustaceans, from lobsters to various types of crab, live on coral reefs where they are able to hide in the many nooks and crannies of the reef and feed opportunistically as well as on plankton and other plentiful food sources which are found at reefs.

Moon Jellyfish | While many people think of jellyfish as an open water species, moon jellyfish regularly lurk around coral reefs, where they are often preyed upon by other fish. Their translucent bodies are incredibly beautiful and take on all sorts of hues as light changes around them. They feed on fish eggs, shrimp and larvae, and are often preyed upon by larger turtle species. ●

"I am delighted to see that the issue of coral reefs is receiving the attention it deserves.

ALBERT II //
Prince of Monaco

MATHEMATICS

Sudoku

#233 PUZZLE NO. 6706475

			5					
	6			7	8			
		3			9	4		1
	2	5	3			7		
3		8						
								4
			1			9		2
	1	9					4	8
6					3		1	

#234 PUZZLE NO. 4237936

	2			3				
				6	9			4
		3		1			5	
9		2	4		3			
	5						8	
4				5	7		3	6
2		9				6		8
					1			
8							1	

©Sudoku.cool

SUDOKU HOW-TO GUIDE

- 1.** Each block, row, and column must contain the numbers 1-9.
- 2.** Sudoku is a game of logic and reasoning, so you should not need to guess.
- 3.** Don't repeat numbers within each block, row, or column.
- 4.** Use the process of elimination to figure out the correct placement of numbers in each box.
- 5.** The answers appear on the last page of this newsletter.

			3	9			1	
5		1					4	
9			7			5		
6	2		5	3			7	
				7				8
7			8			9		3
8		3		1			9	
	9		2		6			7
4					3		6	1

What the example will look like solved

2	4	8	3	9	5	7	1	6
5	7	1	6	2	8	3	4	9
9	3	6	7	4	1	5	8	2
6	8	2	5	3	9	1	7	4
3	5	9	1	7	4	6	2	8
7	1	4	8	6	2	9	5	3
8	6	3	4	1	7	2	9	5
1	9	5	2	8	6	4	3	7
4	2	7	9	5	3	8	6	1



“Coral reefs represent some of the world’s most spectacular beauty spots, but they are also the foundation of marine life: without them many of the sea’s most exquisite species will not survive.”

SHEHERAZADE GOLDSMITH // British environmentalist

DID YOU KNOW?

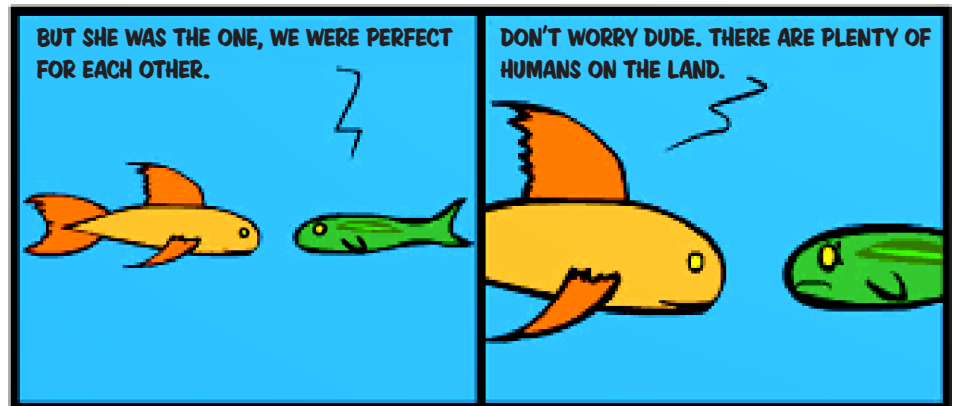
The Great Barrier Reef is the largest structure ever **built by animals**.

They take up a tiny proportion of the world's ocean but account for more than a **quarter** of all ocean-dwelling creatures.

Calcium carbonate is used by corals to grow a shell. It turns into stone over time.

The second largest reef in the world is in the Caribbean and it **protects people** from hurricanes.

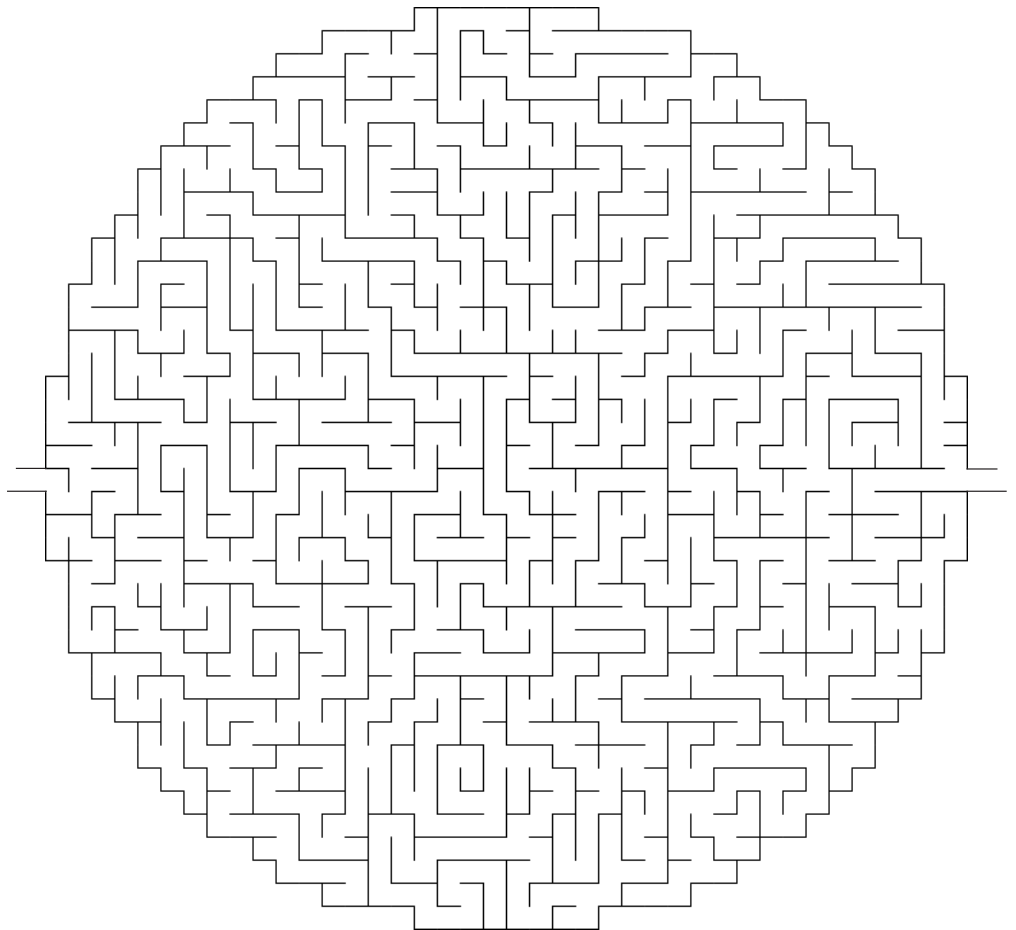
Source: oysterworldwide.com



comictroll.com

Maze ►

This maze is a collection of paths, where there is both a start and ending point. The player starts from the start point and follows a path of their choice, which leads to the end point.



CORAL REEFS CAN GROW SO LARGE THAT THEY CAN BE SEEN FROM **OUTER SPACE**.



CORAL REEFS CAN SUPPORT COMMUNITIES ECONOMICALLY THROUGH **TOURISM**.

“Coral is a very beautiful and unusual animal. Each coral head consists of thousands of individual polyps. These polyps are continually budding and branching into genetically identical neighbors.”

ANTONY GARRETT LISI // American physicist

ART + CULTURE

Coral Reef

BY MEL GIBSON

I wish to live in the coral reef,
to swim all day with fishes.
The colors provided are beyond belief,
like an ocean full of riches.

The Tube Sponge in b'dazzling blue,
and the Sea Squirt gray, green, and white.
Pineapple Coral with red and orange too,
but Sun coral yellow and bright.

The Flame Scallop is often devil red,
the Limpet snow white or piggy pink.
The Flying Gurnard has a gray like led,
as well as a silver like zinc.

With an olive green Sea Turtle I'd like to play,
but avoid the Orange Fire-worm.
I could stare at the plum Purple Urchin all day,
and with the feathery brown duster I'd squirm.

Such a palette of colors under the sea,
many more wait to be found.
Would you like to live on the reef with me,
You may find the beauty profound.

Mel Gibson has been writing since 1992 and finds love poems the easiest to write. They also enjoy writing about nature, horror, and parenthood. They are a stay at home mom and hopes you enjoy their work.

WRITING PROMPT

This poem uses descriptive words, colors and shapes throughout and describes the coral in a way that you can almost visualize it. Use this form of writing or creating to describe something in a way that allows the viewer to picture it in their minds. Share with us a short essay, poem, blog, or illustration of what you have created.



Word Search

E	D	S	T	E	E	R	O	S	I	O	N	L	V
O	E	P	E	E	A	E	S	E	G	N	O	P	S
T	S	N	S	E	L	P	P	A	E	N	I	P	B
L	C	A	R	N	S	D	N	O	S	N	I	E	E
E	R	E	O	R	I	S	P	D	F	E	R	D	D
H	I	A	H	Z	R	T	R	C	E	I	A	L	A
R	P	D	A	N	P	A	L	L	E	T	T	E	Z
D	T	S	E	L	N	R	L	I	R	O	R	I	Z
O	I	L	S	R	A	F	O	A	I	N	Z	P	L
L	V	E	U	T	S	I	D	P	E	P	P	A	E
E	E	G	P	C	A	S	I	E	T	P	N	D	D
C	P	A	P	S	V	H	A	L	I	A	Z	A	E
T	R	E	O	P	L	O	C	E	A	N	L	S	T
S	C	A	L	L	O	P	V	I	E	A	R	E	A

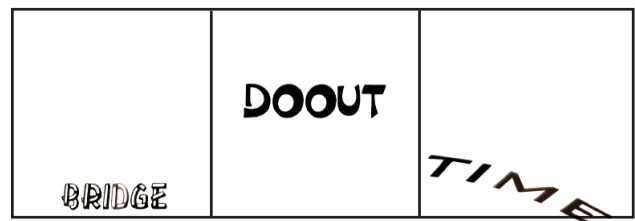
REEF
PALLETTE
SPONGE

GURNARD
OCEAN
PINEAPPLE

SEAHORSE
STARFISH
BEDAZZLED

EROSION
SCALLOP
DESCRIPTIVE

WORD PLAY A Rebus puzzle is a picture representation of a common word or phrase. How the letters/images appear within each box will give you clues to the answer! For example, if you saw the letters "LOOK ULEAP," you could guess that the phrase is "Look before you leap." *Answers are on the last page!*



ENVIRONMENTAL

This Puerto Rican Software Company is Using Satellite Data to Save the Beaches

BY RICHIE HERTZBERG | *The Hill* | June 23, 2022

The Puerto Rican coastline has been receding for many decades due to rising sea levels. And as water levels rise, causing severe erosion, many coastal dwelling Puerto Ricans are left watching their homes fall into the sea.

But a small software company in Puerto Rico called Terra Firma, founded in 2019 by Alejandro Mieses who is indigenous to the island, is using satellite data to dynamically forecast precise erosion pain points that might help Puerto Rican city planners better protect their island in their battle against climate change.

“The problem right now with environmental assessment is that the data is scattered across multiple federal data sets,” Mieses said. “There’s not a database that’s meant to unify them. So Terra Firma’s first mission is to actually unify that data in a way that is useable.”

The company has created a user-friendly software interface that allows environmental scientists, construction professionals and government agencies to create models forecasting, with down-to-the-meter precision, environmental risks like erosion, landslides, flooding, solar exposure, and wind related risks.

Terra Firma’s software is like Google Maps on steroids. Instead of just offering the user a momentary snapshot into a particular geographic region, Terra Firma’s software aggregates data from 1941 to present day, tracking the aforementioned environmental risks.

And with an almost video game style interface, the software allows users to easily forecast up to 30 years of potential damage and erosion just by toggling a few settings. These kinds of forecasts were previously available exclusively to projects with a budget big enough to hire a team of engineers to gather and digest the data. Now that power is returned to the hands of the people and communities interested in protecting their own land.

Since the devastating fallout of Hurricane Maria in 2017, Puerto Rico has scrambled to rebuild a stronger and more fortified island. And with data that can predict precise instances of flooding and erosion, Puerto Rican city planners are able to better prepare for intense weather events similar to Hurricane Maria.

One example of an organization that has teamed up with Terra Firma in an effort to better protect the island from erosion and flooding is Blue Tide Puerto Rico.

Blue Tide Puerto Rico is a nongovernmental organization focused on oceanic scientific investigation and research, as well as promoting and preserving the

Blue Economy of Puerto Rico. After Hurricane Maria destroyed many of the coral reefs that act as a natural barrier protecting the coastline from erosion and flooding,

Blue Tide contracted Terra Firma to design 3D-printed tiles to be installed and serve as an erosion mitigation strategy to fight future storm surges and protect the coast.

“We identified Terra Firma as an asset because it’s a startup company with young person’s capable of working with our request with a fresh new design and with the concept of keeping the environmental impacts of construction to the minimum,” said Wilbert De La Paz, executive director of Blue Tide Puerto Rico.

Thousands of coral tiles are slated to be 3D-printed and installed along the coast of Puerto Rican cities that experienced coral reef loss during Hurricane Maria. The coral tiles are made of clay and form a cylinder that acts as a nest for organic, baby coral plugs. Mieses believes that within 10 years, the clay cylinder will dissolve, leaving a fully fused organic coral reef in its wake.

This coral reef replacement will hopefully act as the first of many successful erosion mitigation strategies that Terra Firma can help build to better protect the island from the increasingly more powerful weather events.

“The way Terra Firma brings hope to a hurricane-prone Puerto Rico is offering the insights to be better prepared for future incoming ones,” said Mieses, “to understand who is at risk, what part of our critical natural infrastructure and grey infrastructure is at risk and how to better protect it.”

Terra Firma is currently operating exclusively in Puerto Rico, but they aim to expand to the southern United States in the coming years. ●



Terra Firma’s software uses data from 1941 to the present to track water flow and forecast risks such as flooding (top). The company was contracted to design 3D-printed tiles to serve as part of an erosion mitigation strategy (middle). The clay tiles form a cylinder that acts as a nest for organic, baby coral plugs (bottom).

ECOLOGY

Scientists are Trying to Save Coral Reefs | Here's What's Working

BY SARAH GIBBENS | *National Geographic* | June 4, 2020

The world's coral reefs do more for the planet than provide underwater beauty.

They buffer shorelines from the effects of hurricanes. An estimated 500 million people earn their livelihoods from the fishing stocks and tourism opportunities reefs provide. The tiny animals that give rise to reefs are even offering hope for new drugs to treat cancer and other diseases.

Despite their importance, warming waters, pollution, ocean acidification, overfishing, and physical destruction are killing coral reefs around the world. Schemes to save those reefs are as creative as they are varied; most recently, scientists released data showing that marine protected areas can help save reefs if they are placed in just the right spots. Genetics is also becoming a larger area of coral research.

Parks under the sea

Scientists often compare coral reefs to underwater rainforests, yet unlike the leafy plant base of a forest, corals are animals. The soft polyps inside the hard parts of corals are naturally translucent and get their famously vibrant color from algae living inside them.

When corals experience stress from hot temperatures or pollution, they end their symbiotic relationship with this algae, typically expelling them and turning white, though one recent study indicates some coral turn a bright neon color when stressed. Coral are still alive when they bleach, but they're at risk—essentially immunocompromised—and many eventually starve and die, turning a dark brown.

People first noticed coral bleaching events in the 1980s. The problem intensified in 2016, when an El Niño weather pattern, which causes warmer waters in the Pacific Ocean, mixed with an already unseasonably warm ocean and killed off a third of the corals on the Great Barrier Reef. Since then, roughly half the corals on Australia's famous reef have died in subsequent bleaching events, jeopardizing an underwater landscape 1,500 miles long.

Scientists around the world are looking for all kinds of ways to protect and maybe even revive corals. One option is to create more marine protected areas—essentially national parks in the ocean. Scientists say creating marine refuges, where fishing, mining, and recreating are off limits, make the reefs healthier, and so more resilient.

An estimated 4,000 fish species, and some 25 percent

of marine life, depend on coral reefs at some point in their existence. Fish keep the algae that grow on corals in check, allowing corals to breathe and access sunlight.

While an MPA won't protect corals from heat waves, these natural safe zones can keep fisheries more sustainable in the long term, and fishers around well-managed MPAs often benefit from the “spillover” of healthy fish stocks that populate surrounding waters.

At a talk hosted by the Woods Hole Oceanographic Institution on Wednesday, renowned marine biologist Sylvia Earle promoted the idea of using marine parks to protect coral, which she does through her organization Mission Blue.

“Reefs that have been protected or not yet exploited by fishing impacts survive when nearby places do not,” she says.

Innovation to the (immediate) rescue

Beyond such nature preserves, some conservationists are looking to more hands-on methods. One research center in the Florida Keys is exploring a form of natural selection to keep corals afloat.

The reef system in the Keys has been hit hard by climate change and disease, which is especially tough, because corals there help support fisheries worth an estimated \$100 million every year. In addition, corals off Florida's coasts are polluted by agricultural and sewage runoff.

The additional stress from warming waters is like “the proverbial nail in the coffin,” says Erinn Muller, the science director at the Elizabeth Moore International Center for Coral Reef Research and Restoration at the Mote Marine Laboratory in Sarasota, Florida.

To keep the wild ecosystem alive, Muller and her team are harvesting samples of the corals that have survived the environmental stresses naturally, breeding them by hand, and reattaching them to the reef. At any given time, the center has 46,000 corals growing on underwater plastic lattices in its nursery. So far, the center has regrown over 70,000 corals from five different species on damaged reefs.

In the Bahamas, Ross Cunning, a research biologist at Chicago's Shedd Aquarium, is focusing on corals



The coral reefs around Fiji cover 3,800 square miles and face threats from climate change, overfishing, and pollution.

Photograph by Greg Lecoeur, Nat Geo Image Collection

“Ice ages have come and gone. Coral reefs have persisted.”

SYLVIA EARLE // American marine biologist

with robust genes that could make them natural candidates for restoration projects. He recently published a study of two Bahamian reefs, one that seemed to survive an intense 2015 heat wave, and one that didn't.

"It sets the stage to find out which genes are responsible for thermal tolerance," says Cunniff, adding that he hopes identifying those genes will help scientists one day breed more heat-tolerant coral.

In Massachusetts, Cohen's research has found two key elements that seem to protect corals. The first: internal waves beneath the ocean's surface that bring cooler currents to heat-struck corals, essentially air-conditioning them as temperatures rise. The second: adaptation, a trait that corals found in Palau's warm lagoons seem to exhibit.

"What we've realized is these corals are sitting in naturally hot water all the time," she says. On average, these lagoons submerge coral in water that is two degrees Celsius warmer than the water outside the lagoons. "We think the fact that they can deal with these higher temperatures is built into their genetics and allows them to deal with the heat waves."

She's also found evidence of corals evolving more quickly in the past two decades to withstand rapidly warming temperatures. The big question scientists are now investigating, says Cohen, is whether there's a cap on how much more heat corals can adapt to.

Cohen calls these regions with heat-adapted corals as "super reefs," and like Friedlander, advocates for using marine reserves to protect them.

A race against warming

Muller notes that their efforts on the Florida reefs can help keep them from what she describes as "functional extinction." But she says the reefs ultimately won't be restored to their potential until their environment becomes more hospitable to their survival.

Global warming is "raising the background temperature," compounding regular heat waves and making them even deadlier for corals, says Kristopher Karnauskas, an atmospheric scientist at the University of Colorado Boulder who recently published a study investigating the physical causes of the 2016 event.

The oceans absorb and store heat very efficiently; as Earth warms, the oceans take in over 90 percent of the planet's heat trapped in the atmosphere by human-generated greenhouse gases. But their heat-storing capacity isn't limitless, and excess heat over time takes its toll on ocean inhabitants.

In evolutionary history, corals date back 400 million years, and with each global temperature change Earth has undergone, corals have adapted — but never as quickly as they must today.

"We know that because there have been six major coral reef extinctions in the geologic past where they were basically wiped out. All those have been associated with excessive heat and ocean acidification," Cohen says. "Coral reefs always come back, but it takes tens of thousands of years."

Now, with climate change-driven temperatures rising at a rate higher than corals have ever had to naturally adapt to, Cohen says, "we don't have that kind of time." ●

✎ Edited for space and clarity

RANDOM-NEST

Coral Reefs

FROM ICRIFORUM.ORG

What does a coral reef look like? | It was Charles Darwin who originally classified coral reefs as to their structure and morphology, and described them as follows:

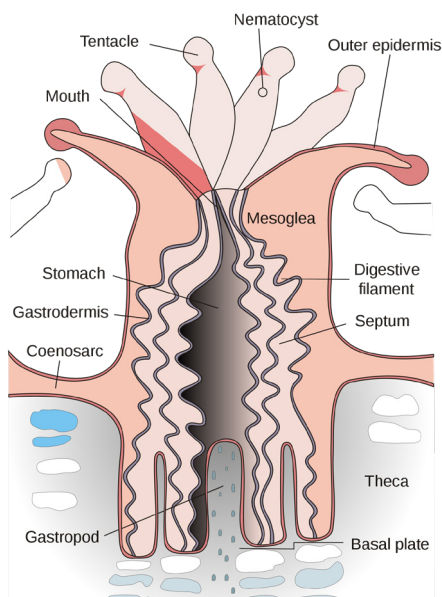
Fringing reefs lie near emergent land. They are fairly shallow, narrow and recently formed. They can be separated from the coast by a navigable channel (which is sometimes incorrectly termed a "lagoon").

Barrier reefs are broader and lie farther away from the coast. They are separated from the coast by a stretch of water which can be up to several miles wide and several tens of metres deep. Sandy islands covered with a characteristic pattern of vegetation have sometimes formed on top of a barrier reef. The coastline of these islands is broken by passes, which have occupied the beds of former rivers.

Atolls are large, ring-shaped reefs lying off the coast, with a lagoon in their middle. The emergent part of the reef is often covered with accumulated sediments and the most characteristic vegetation growing on these reefs consists of coconut trees. Atolls develop near the sea surface on underwater islands or on islands that sink, or subside.

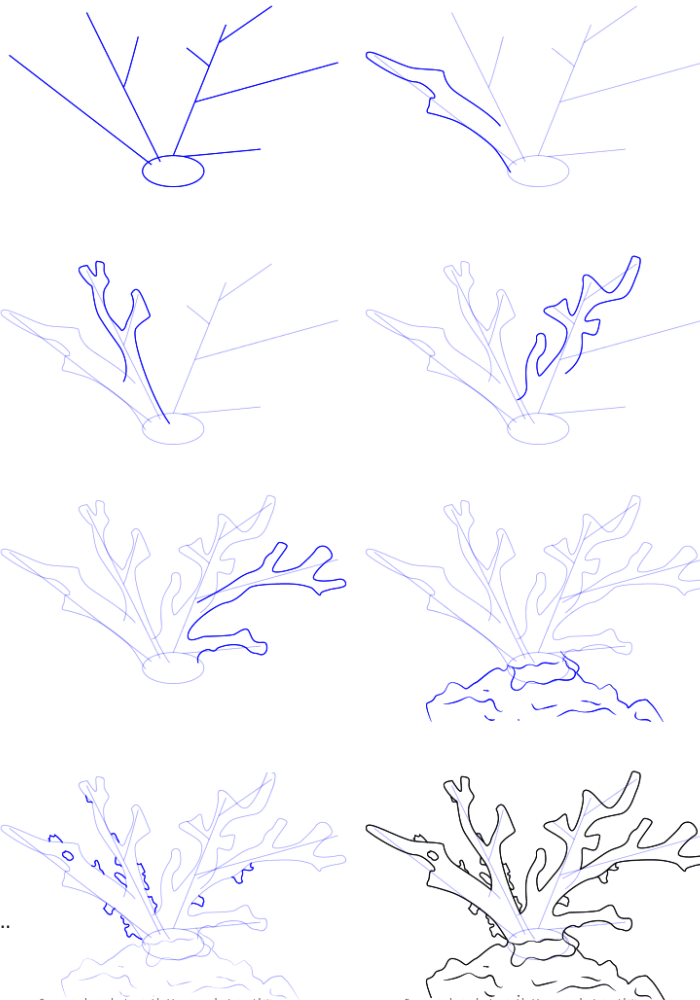
Where are they found? | Coral reefs are found throughout the oceans, from deep, cold waters to shallow, tropical waters. Temperate and tropical reefs however are formed only in a zone extending at most from 30°N to 30°S of the equator; the reef-building corals preferring to grow at depths shallower than 30 m (100 ft), or where the temperature range is between 16-32°C, and light levels are high.

Based on current estimates, shallow water coral reefs occupy somewhere between 284,000 and 512,000 km² of the planet (cold-water (deep) coral reefs occupy even more area). If all the world's shallow water coral reefs were crammed together, the space would equal somewhere between an area of land ranging from the country of Ecuador (the low estimate) to Spain (the higher estimate). This area—about 198 thousand square miles in an ocean of 140 million square miles—represents less than 0.015 percent of the ocean. Yet coral reefs harbor more than one quarter of the ocean's biodiversity. That's an amazing statistic when you think about it: no other ecosystem occupies such a limited area with more life forms.



HOW
TO
DRAW

...



artprojectsforkids.org

RED CORAL ...

Words of Encouragement

I am always amazed when I learn more about our world. The coral reefs this week brought us a small glimpse of the ocean and its amazing inhabitants. Their beauty is overwhelming and the realization of their importance to our way of life leaves me in awe. On a recent trip to Puerto Rico I was able to visit some coral reefs and couldn't believe what I was witnessing. The fish surrounding them were so colorful and the more I read about them this week, the more I am able to understand their contributions. I am so grateful that there are individuals working to protect these creatures and expand their presence.

We hope you have enjoyed this edition of *The Warbler*. We are constantly looking for new themes and content and value your opinions and voices. Please feel free to send us your comments, questions, and ideas to the address listed below. If you are a student of APAEP, feel free to share your thoughts with your instructors. If you were inspired by this newsletter or any others you had access to, we would love to see your words or illustrations. We hope you have an amazing week and know you are constantly in our thoughts.

Tammy and the APAEP Team



Send ideas and comments to: APAEP
1061 Beard-Eaves Memorial Coliseum // Auburn University, AL 36849

Answers

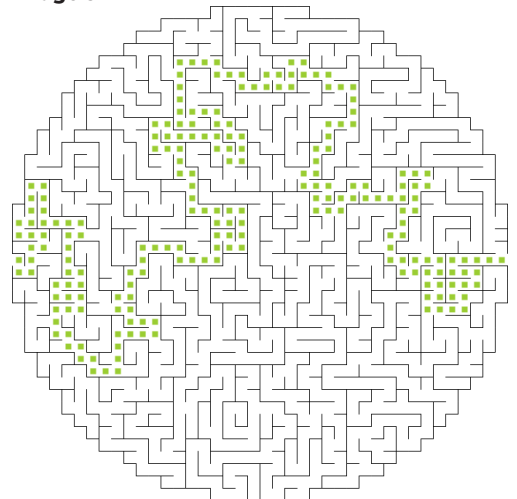
SUDOKU #233

8	7	4	1	5	3	9	2	6
6	5	1	8	2	9	3	4	7
2	9	3	7	6	4	8	5	1
1	2	9	5	3	8	7	6	4
7	8	5	6	4	1	2	3	9
3	4	6	9	7	2	5	1	8
9	6	2	3	1	7	4	8	5
4	1	7	2	8	5	6	9	3
5	3	8	4	9	6	1	7	2

SUDOKU #234

7	8	4	6	1	9	2	5	3
2	1	5	8	3	7	6	9	4
6	3	9	2	4	5	7	8	1
1	7	8	9	5	4	3	6	2
3	4	2	7	8	6	9	1	5
9	5	6	1	2	3	4	7	8
8	6	3	5	7	2	1	4	9
4	9	1	3	6	8	5	2	7
5	2	7	4	9	1	8	3	6

Page 5 MAZE



Rebus Puzzle

Page 6

1. Low bridge
2. Do without
3. Time's running out

UNTIL NEXT TIME