

RAINFORESTS OF THE MAYA

Teacher's Guide

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The First Americans

If you go back in time 15 or 20 thousand years, the Americas looked much different than they do today. First of all, the climate was different.

This was towards the end of the Pleistocene epoch. Glaciers covered as much as 30 percent of the Earth's land. It was cooler, drier, and massive animals like mammoths, giant sloths and saber-toothed cats roamed.

Sea levels were also much lower, exposing a strip of land that connected Siberia with Alaska. This is referred to as the *Bering Land Bridge*, and for a small window of geologic history, before the climate began to warm and sea levels rose again, it was possible for humans to cross from Asia into a new continent.

Most anthropologists believe that humans crossing this land bridge were the first Americans, and they quickly spread throughout North, Central and South America.



The Maya

The Early Maya

The first Americans were hunter-gatherers. As the climate began to warm, as early as 7,000 BC, Native Americans in Central America began to domesticate plants. Corn, squash, beans, chiles, tomatoes, cacao, avocados...these are all staple foods that we rely on today, and all are plants that had been selectively bred and thereby domesticated over time by ancient farmers in Central America.



The shift towards agriculture and the domestication of plants allowed early Americans to settle down; to “put down roots” rather than live a nomadic life. In the Yucatan Peninsula, these early farmers began to come together into complex societies around 2,000 BC. This was the beginning of the Maya Civilization.

Maya Culture



Palenque, a major Maya site in Chiapas, Mexico

The Maya are most known for an extraordinary burst of culture during what is known as the Maya Classic Period from 250 AD – 900 AD. During this time, dozens of powerful city-states flourished. There were extensive trade networks between Maya cities with roadways connecting them. Tikal, Calakmul, Palenque and many others built massive stone structures, produced beautiful sculptures and pottery, and recorded aspects of their histories using complex hieroglyphic writing.

The Mayan language is really a family of several Mayan dialects. Mayan written language was logosyllabic, combining about 550 logograms (glyphs which represented whole words) and 150 syllabograms (glyphs which represented syllables). It wasn't until the 1970's and 1980's that researchers were finally able to decipher Mayan writing. Today we know much more about the history of the Maya by being able to read the hieroglyphic writing that decorated many of the temples, monuments, pottery and even a few surviving paper codices that the Maya left behind.



The Maya were keen observers of the heavens even though they did not have telescopes. By keeping track of the movements of stars and planets they developed the world's most accurate calendar. They were also ahead of their time by introducing the concept of zero.

These advancements in mathematics, astronomy and a written language allowed the Maya to keep accurate records and keep track of the seasons. This was incredibly important for, among other things, agriculture. The Maya knew just the right time to plant and harvest.

Religious Beliefs

The Maya were **polytheistic**: believing in many gods. Their supreme god was Itzamna, the creator of the universe. Itzamna was so sacred he was believed to play no part in human life. The Popol Vuh is the Maya creation story, translated into Spanish by missionaries in the 18th century.

Many other deities were associated with things in nature. Chac, for example, was the god of lightning, thunder and rain. There was a sun god, a mountain god, even a corn god. The giant ceiba tree, referred to as the Tree of Life, was believed to connect the Underworld, the Middle world (inhabited by humans) and the Heavens.



Stucco sculpture depicting Chac



Mural at Bonampak depicting Maya bloodletting ceremony

The Maya believed the gods were sustained by human blood. This means they required sacrifices. Turtles, deer, turkey, jaguars and other animals were sacrificed to the gods but the most valuable sacrifice was human.

Ritual blood-letting was common. One method was to pierce the tongue with a stingray spine through which a rope studded with thorns was run. Blood-soaked strips of paper were then burned as an offering to the gods.

The Maya Ball Game

The Maya also liked to have a good time. They played a variation of a ball game which was also played by other cultures and civilizations in Mesoamerica. A rectangular ball court with sloping stone walls was often a focal point of Maya cities. Many also featured two stone hoops. Two teams would play, attempting to keep a heavy rubber ball from touching the ground with the goal of scoring on the opposing team's endzone. They could only use their hips, knees and elbows.

Ball court at Coba



The ball game wasn't strictly for sport. It had religious significance and was a representation of the conflict between good and evil. Many myths surrounding the ball game have suggested that losers, or sometimes the captain of the winning team, would be sacrificed at the end. Experts believe that occasionally the ritual ball game was used as an alternative to war to settle disputes between rival cities.

Architecture

If there is one thing the Maya were famous for it was their monumental buildings. Towering pyramids in sites like Tikal and Copan mystified explorers from all over the world for centuries. Amazingly, the Maya built these structures without the use of metal tools or the wheel.

The Maya had plenty of limestone under their feet and they used tools of harder stone like flint or obsidian to shape the softer limestone into blocks. They used logs to roll large blocks into place and levers to stand them upright. They also used a "plumb bob" which is essentially a string with a weight on the end to make sure their structures stood perfectly straight.



Temple of the Great Jaguar in the city of Tikal

One architectural advancement was the use of the **corbel arch**. The corbel arch used overlapping stones to create a basic triangular archway that helped to distribute the weight of the stones above while increasing the volume of the space below. While it wasn't quite as efficient or strong as the Roman arch, this innovation helped the Maya create larger interior spaces in their buildings.

A technique using heated and crushed limestone produced a powder that was used to create cement and stucco. The cement used by the Maya was even better than that used by the ancient Romans, allowing for the large-scale stone architecture that they were known for. Many of their buildings were covered with stucco and decorated with intricate stucco reliefs.

Political Structures

The Maya civilization was never unified under a single ruler or government. Rather, it was a collection of city-states, each with its own ruling class. These city states traded with each other and in many cases a larger city-state would rule over smaller vassal cities. War between cities was common.

Kings were said to be descendants of the gods. Ruling classes required tributes from the commoners. This included labor, goods, offerings and portions of their harvests. Commoners were also required to work on annual labor projects such as the building of temples, palaces and causeways.

The Decline of the Maya

The Maya classic period ended around 900 AD. Large cities like Palenque and Calakmul were abandoned and large-scale building ceased. The Maya, however, survived and some smaller cities were still occupied as late as the early 16th century when the Spanish arrived. The reasons for the collapse of the great cities are not fully known, however there are many theories.

Theories about the Maya collapse include the disruption of trade routes, invasions by neighboring Toltec warriors, and epidemic diseases. One prevailing theory suggests that rapid climate change and extreme drought during the Late Classic Period was what tipped the scales. Others also suggest that the Maya deforested much of their land, contributing to an environmental collapse.

The truth is we may never fully understand how and why the Maya people abandoned their cities and faded into the jungle. It is likely that it was a combination of factors. But the Maya people lived on, and today millions of people in the Yucatan Peninsula, in Guatemala, Belize, El Salvador and Honduras are the direct descendants of the ancient Maya.

Lands of the Maya

Geology

The geology of Central America and the Yucatan Peninsula is varied and fascinating. Several tectonic plates converge in the region resulting in lots of seismic activity. Earthquakes are frequent in much of Central America, and a chain of volcanoes, many of which are active, extends from Guatemala all the way down to northern Panama.

The Yucatan Peninsula, which was home to many important Maya cities, is one of the youngest land formations in this region. It is basically a plateau of limestone rock, created by sediment and the skeletons of ancient marine organisms millions of years ago. The Peninsula is wide and flat.

Because of the porous, soluble nature of the limestone rock foundation, rainwater drains quickly into the bedrock. There are hardly any above-ground rivers in the Yucatan Peninsula. There are, however, vast networks of



A large cenote in the Yucatan Peninsula

underground caverns and rivers carved out over eons of time by the slightly acidic water that courses through the rock. **Karst topography** refers to a landscape, like that found in the Yucatan and parts of Florida, formed by the dissolution of soluble rocks such as limestone.

In places, the ceiling of an underground cave might collapse, leaving behind a hole. Holes in the ground gave the ancient Maya a way to access the pure fresh water below. These are referred to as **cenotes**, and there are thousands of them sprinkled throughout the region. Not only did cenotes give the Maya access to water, but the Maya also believed they were gateways to the underworld. Some are littered with broken pottery and sacrificial remains. *Watch the video at:*



<http://www.odysseyearth.com/videos/cenote-passage-to-the-maya-underworld/>

The Lungs of the Earth

Rainforests are forest that receive between 250 and 450 centimeters of annual rainfall, most rainforests occur between 10 degrees north and 10 degrees south of the Equator. They are known for their incredible productivity and biodiversity, home to half of the world’s plants and animals. Unfortunately, tropical forests are disappearing at an alarming rate.

Rainforests are often called the “lungs of the Earth.” This is because of the role that plants play in moderating the Earth’s climate, in part due to the process of photosynthesis. With plenty of sunlight and lots of rain, tropical forests are rich with plant-life. Plants absorb carbon dioxide from the air and water through their roots. By harnessing the energy of the sun, carbohydrates are synthesized and used to nourish the plant and help it grow. Oxygen is a bi-product of this process, released by the plant back into the atmosphere. Excess water is also released in a process called transpiration. In tropical forests, transpiration from plants keeps the atmosphere humid and helps build more rain clouds. It’s a self-feeding cycle. *Watch the video at:*



<http://www.odysseyearth.com/videos/rainforests/>

Animal biodiversity

Central America contains less than 1 percent of the world’s land surface, however it is home to more than 7 percent of the planet’s biodiversity. It is also the physical link between South America and North America. Many species of animals, such as howler monkeys, Baird’s tapirs and jaguars rely on natural wildlife corridors within Central America to roam and populate throughout the Americas. Because Central America is the bridge between two continents, it is home to animals that may have originally migrated from either of its neighboring continents.



Adult male Baird's tapir

Animal biodiversity is the result of the diversity and productivity of plants, the **producers**. Because of the tropical climate in the region, thousands of species of plants bear fruits and seeds at various times throughout the year. There is always something to eat.

The most productive level of the rainforest is high up in the canopy. Monkeys are excellent climbers and some, like the spider monkey, are equipped with **prehensile** tails. These tails are designed to wrap around and grip tree-limbs, a handy trick for life in the forest. Monkeys with prehensile tails are only found in the New World.

In terms of sheer numbers, insects rule the rainforest. Despite having tiny brains, ants can form incredibly complex societies. An ant species can have several polymorphic forms. Each morph might look different and perform a different role, even though they are all part of the same species.



Leaf cutter ants form massive underground colonies, sometimes 25 feet deep. Leaf cutter workers scour the forest, using their sharp mandibles to harvest leaf trimmings. The leaves are not eaten. Instead, these ants, which are essentially farmers, use the leaf material to cultivate fungus in their underground homes. The fungus, is what they eat.

In the rainforest ecosystem, the plants and animals are in a constant struggle for survival. Sometimes partnering up is the best strategy. The bullhorn acacia tree has developed an interesting collaboration with species of ants called bullhorn ants.

The bullhorn acacia tree has bulbous thorns, many of which are hollowed out with a hole near the tip. The thorn becomes home to bullhorn ants, which scurry around on the tree, looking for invaders. A herbivore like a deer attempting to munch on the tree's tender leaves, will be attacked by mobs of bullhorn ants. Interestingly, the bullhorn acacia tree also produces special food packets, which feed the ant in return for protecting it. This is a great example of a symbiotic relationship called **mutualism**.

Mutualism is a relationship between organisms in which both receive a benefit. **Watch the video at:**

<http://www.odysseyearth.com/videos/symbiosis-mutualism/>



Another interesting symbiotic relationship is **commensalism**. With this relationship, one organism benefits while the other receives neither benefit or harm. A good example of this is the army ant and the ant bird. Army ants form large, nomadic colonies that sweep through the forest, dismembering and eating just about any small animal in their paths. Insects fleeing this horde, are picked off by birds that have learned to follow army ant colonies. There are several species of "ant birds," not all related, but each species of ant bird benefits from the chaos created by roving army ant colonies. The ants, however, get nothing from the arrangement.

Watch the video at:

<http://www.odysseyearth.com/videos/symbiosis-commensalism/>



The Resplendent Quetzal

As we learned, the Maya had a very close link to nature and even worshiped many gods associated with plants and animals. Monkeys and Jaguars were sacred, but perhaps no creature was as sacred as the **resplendent quetzal**. This beautiful member of the trogon family was associated with the Principal Bird Deity, which was connected with the valuable things the earth had to offer.



Maya kings used the male quetzal's long, iridescent green streamer feathers to decorate their kingly headdresses. The streamer feathers are shed and re-grown every breeding season, so the male quetzal would be caught, its three streamer feathers removed, and then the bird would be released safely. It is said that anyone in the Maya world caught killing a quetzal would be sentenced to death.



The resplendent quetzal is only found in high-elevation cloud forests from southern Mexico south to northern Panama. They primarily feed on fruits, especially wild avocados, though they occasionally eat insects and lizards.

The quetzal's beak is not designed for chipping wood. The birds nest in dead, rotted trees, and will occupy the discarded nest of a woodpecker. Dead trees are important. Although the quetzal does not create the nesting cavity from scratch, it will modify and enlarge the cavity with its beak. This means the wood needs to be nice and soft.

Present and Future

Rainforests in peril

The world's rainforests are home to an extraordinary diversity of plants and animals, but, sadly, rainforests are disappearing at an alarming rate. In El Salvador, for example, only 17 percent of the land is now forested. Much of this loss is to make room for export crops such as coffee, sugar, bananas and palm oil. This is a trend that has existed since the introduction of European-style monoculture in which a field is cleared to plant a single crop. Modern agriculture also relies heavily on herbicides and pesticides, and huge amounts of fertilizers to enrich the soil.

Other factors such as development and road construction are fragmenting the remaining forests, disrupting the natural corridors used by animals like jaguars to migrate and roam. In most Central American countries, illegal logging is a huge problem. In Honduras, up to 85 percent of timber felled is illegal, much of it exported to the USA.

The loss of these forests poses serious threats to biodiversity. A recent report by the United Nations warns that as many as 1 million species of the earth's plants and animals are threatened with extinction. The number one cause is man-made changes to the land and sea.



The loss of tropical forests may also be accelerated by climate change. Ironically, the loss of these forests also contributes to climate change. Through photosynthesis, plants remove carbon dioxide from the atmosphere. Carbon dioxide is what we call a “greenhouse gas.” Tons of carbon dioxide are released every day through the burning of fossil fuels like coal and gasoline. As a greenhouse gas, carbon dioxide traps heat in the atmosphere, essentially creating an insulating blanket which is causing the planet to warm. Not only do plants remove carbon dioxide from the atmosphere, they convert it into compounds like sugar that are stored safely in the plant’s tissues. We call this “carbon sequestration.” When plants rot or burn, however, the carbon is released back into the environment. Protecting remaining forests and returning lands back to forest are two of the best ways we can combat climate change.

The Maya Milpa Cycle

Through countless generations of accumulated knowledge, the Maya became master forest gardeners. Corn was their staple crop, however, as we learned, they grew many other domesticated fruits, vegetables and grains. The Maya called the plot of land that they cultivated a *milpa*, and their system of agriculture was much different than the European model that we are used to, with several key differences.

First, Maya milpa farming was a cycle which required hard work and expansive knowledge of the plants that grew in the area. The cycle started by slashing and burning a small area of forest. This might sound bad, but the Maya used low-heat fire and would only burn a small area of forest. The charcoal was incorporated into the soil, enriching it with nutrients.



Second, they did not plow their land. In many parts of Central America and the Yucatan, the ground was too rocky to plow anyway. Instead, a farmer would use a sharpened stick to poke a hole into the soil into which he would drop a few seeds. By doing it this way and not plowing, networks of roots that bound the earth together were kept intact, and the earthworms and insects living in the soil were not disturbed. Because of this, soil erosion was never a problem, and all of the invertebrates living there continued their important work of aerating and enriching the earth.

Third, the Maya planted mixed crops. It would usually start with corn, but after the corn stalks had reached a certain height, beans might be planted next to the corn. Bean plants would wind around the stalks which served as scaffolding. Plants like beans are important to keep the soil fertile because they return nitrogen to the soil. Other plants, like squash might be planted in between the rows, acting as ground cover to prevent weeds from taking over.



During this time, seeds drifting in from the surrounding forests would sprout in the farmer's milpa. After a few years, the farmer would allow some of these plants to continue growing as long as they were useful to the farmer in some way. It might be a

Illustration of Maya forest garden with secondary forest and milpa plots

cohun palm, for example, whose fronds were useful for thatching. Or perhaps it was a cacao tree, its seeds used to make chocolate. The Maya, in fact, had uses for hundreds of varieties of plants that they relied on for food, for medicine, for construction...even to feed the animals, some of which were hunted for their meat. After several more years, the milpa which once grew corn and beans, would be a forest once again. What might look like wild, untamed rainforest, however, was full of bounty for the Maya as well as the wildlife with which they shared the land.

Now that the milpa had returned to forest, the farmer would select another area of rainforest to cut, burn and plant a new milpa. This process worked as a cycle, allowing the Maya to keep approximately two thirds of land forested while still providing for their needs.

Today, the knowledge passed on through the generations still lives in a handful of modern Maya farmers who are carrying on the tradition. Although there are fewer and fewer forest gardeners left, they may hold the key to a more sustainable future.

With the effects of climate change becoming more and more apparent, scientists are taking a hard look at modern agricultural practices and how they may be contributing to pollution and climate change. Many are also looking at indigenous agriculture. The Maya milpa cycle stands out as one of the most productive and sustainable models we have found. *Watch the video at:*

<http://www.odysseyearth.com/videos/sustainable-farming-the-maya-milpa-cycle/>



Quiz

Vocabulary: Match the word or term with the correct definition

<i>Karst topography</i>	
<i>Milpa</i>	
<i>Polytheistic</i>	
<i>corbel arch</i>	
<i>Mutualism</i>	
<i>Commensalism</i>	
<i>Resplendent quetzal</i>	
<i>Producer</i>	
<i>Prehensile</i>	
<i>Cenote</i>	

A	A natural pit or sinkhole resulting from the collapse of limestone bedrock, exposing groundwater underneath
B	Adapted for seizing or grasping especially by wrapping around
C	A symbiotic relationship in which both organisms benefit
D	A plot of land cultivated by the Maya and other indigenous people of Mesoamerica
E	A beautiful species of bird found in the mountains of Central America which was sacred to the Maya
F	organisms that make high energy compounds such as sugars. Green plants are an example.
G	A landscape formed by the dissolution of soluble rocks such as limestone
H	A religion consisting of multiple deities
I	A symbiotic relationship in which one organism benefits while the other receives neither benefit or harm
J	An architectural feature that uses overlapping stones to create interior spaces in buildings

Multiple choice (circle the correct answer or answers)

1. Which of the following were innovations by the Maya? Circle all that apply:

The telescope

The concept of zero

Cement and stucco

2. The Maya God of thunder, lightning and rain was named:

Itzamna

Chaac

Quetzal

3. Cenotes are formed when the soluble limestone bedrock dissolves from:

Magma from volcanoes

Saliva from leafcutter ants

Slightly acidic rainwater

4. Rainforests are often called:

The Coral Reefs of the Earth

The Limbs of the Earth

The Lungs of the Earth

5. Which are plants that were domesticated by the Maya and their ancestors? Circle all that apply:

Chile peppers

Corn

Squash

Answer Key

Vocabulary: Match the word or term with the correct definition

<i>Karst topography</i>	G
<i>Milpa</i>	D
<i>Polytheistic</i>	H
<i>corbel arch</i>	J
<i>Mutualism</i>	C
<i>Commensalism</i>	I
<i>Resplendent quetzal</i>	E
<i>Producer</i>	F
<i>Prehensile</i>	B
<i>Cenote</i>	A

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