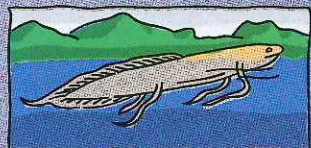
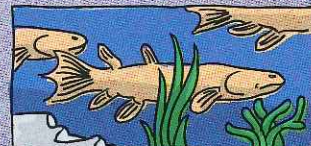




# Fins, Limbs, and Bony Wings

Did you know that some snakes have claws? Like your tonsils, their claws are useless. They're left over from a time when snakes were much more lizardlike. Their legs gradually shrank to nothing. Being legless must have helped snakes in some way, perhaps by letting them slide in and out of burrows faster.

Changing to suit the environment is called adaptation. The fossil record clearly shows that many species have adapted over time—including humans. Your limbs could very well have become fish fins or bat wings. But our ancestors needed to walk and climb, not swim or fly. For the same reason, we have gill slits that disappear when our bodies are still forming. (The gill slits aren't working gills but rather remnants of gills.) Before birth, human bodies even create—and then absorb—a small tail!



▲ **FISH DEVELOPED** many kinds of fins for swimming and steering in water. Lungfish adapted their fins for walking on land. The fins became stronger and acted more like stilts than paddles. The first amphibians took this adaptation one step further. They developed four strong, jointed legs specially suited for walking.

► **A CLOSE-UP OF** a pterosaur shows that the wings are just modified arms and hands. The fourth finger is extralong to provide a frame for the wing membrane. The other clawed fingers stop short at the joint.



**Archaeopteryx** was one of the first known birds. It was a bird because it had feathers. Fossil

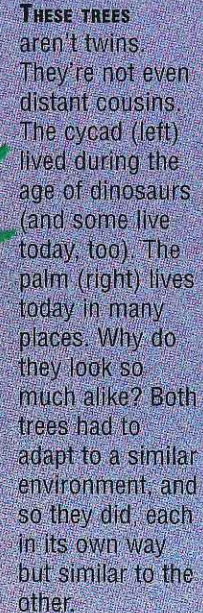
imprints clearly show these feathers. But *Archaeopteryx* had teeth, clawed fingers, and a bony tail like a reptile. In fact, some German

experts mistook a specimen for *Compsognathus* ("pretty jaw"), a small meat-eating dinosaur!

▼ **BATS HAVE A** design similar to *Archaeopteryx*, even though they're mammals and not reptiles.

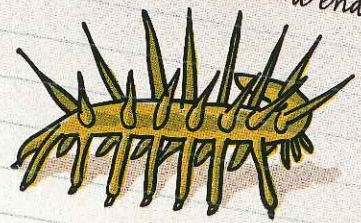
► **IN BIRDS, THE** arm bones have fused together, and the wings are made of feathers rather than skin membrane.

**THESE TREES** aren't twins. They're not even distant cousins. The cycad (left) lived during the age of dinosaurs (and some live today, too). The palm (right) lives today in many places. Why do they look so much alike? Both trees had to adapt to a similar environment, and so they did, each in its own way but similar to the other.



**Creature Feature**  
**Hallucigenia** ("creates illusions")

**Time:** 550 mya  
**Place:** Western Canada  
**Close in size:** Dime to a quarter  
**Fossil fact:** It walked on seven pairs of tentacles—each with a pincer at the end—and had seven pairs of sharp spines. In 1977, scientist Conway Morris drew the animal upside down. He believed that it walked on spines and waved its tentacles in the water. He incorrectly guessed that each tentacle had a tiny mouth at the end.



**FOSSIL HUNTERS**

**ROBERT BAKKER** (born 1945) In the 1970s, Bakker threw out decades of dinosaur theories. He had better ideas. He believed dinosaurs were

warm-blooded and active, like birds. Then in 1986, he went further. He proposed that birds were the descendants of dinosaurs. They belonged in the group Dinosauria. Today, many scientists

accept this view. Do you? How are dinosaurs like birds? (answer on back cover)

**CHECK IT OUT!**

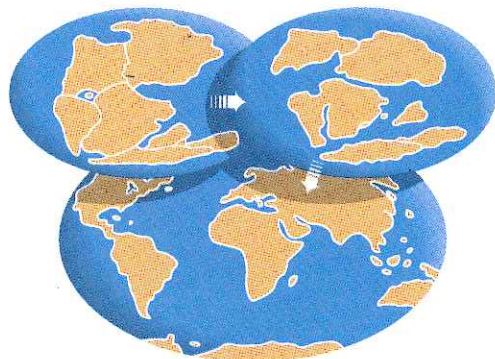
Which came first on land—plants or animals? (answer on back cover)

► **A MAJOR HUMAN** adaptation is brain size. The graph shows our volume of brain compared to those of our ancestors and mammal relatives. Neanderthals had bigger brains than *Homo sapiens sapiens* (that's us!), but they had smaller cerebrums (the "smart" part).

Primate	Brain Volume (in liters)
<i>Australopithecus afarensis</i> 4 million years ago	0.45
<i>Australopithecus africanus</i> 3 million years ago	0.45
<i>Homo habilis</i> 2–1.5 million years ago	0.75
<i>Homo erectus</i> 1.6 million years ago	1.00
<i>Homo sapiens neanderthalensis</i> 200,000 years ago	1.50
<i>Homo sapiens sapiens</i> 40,000 years ago	1.40
Modern apes	0.50

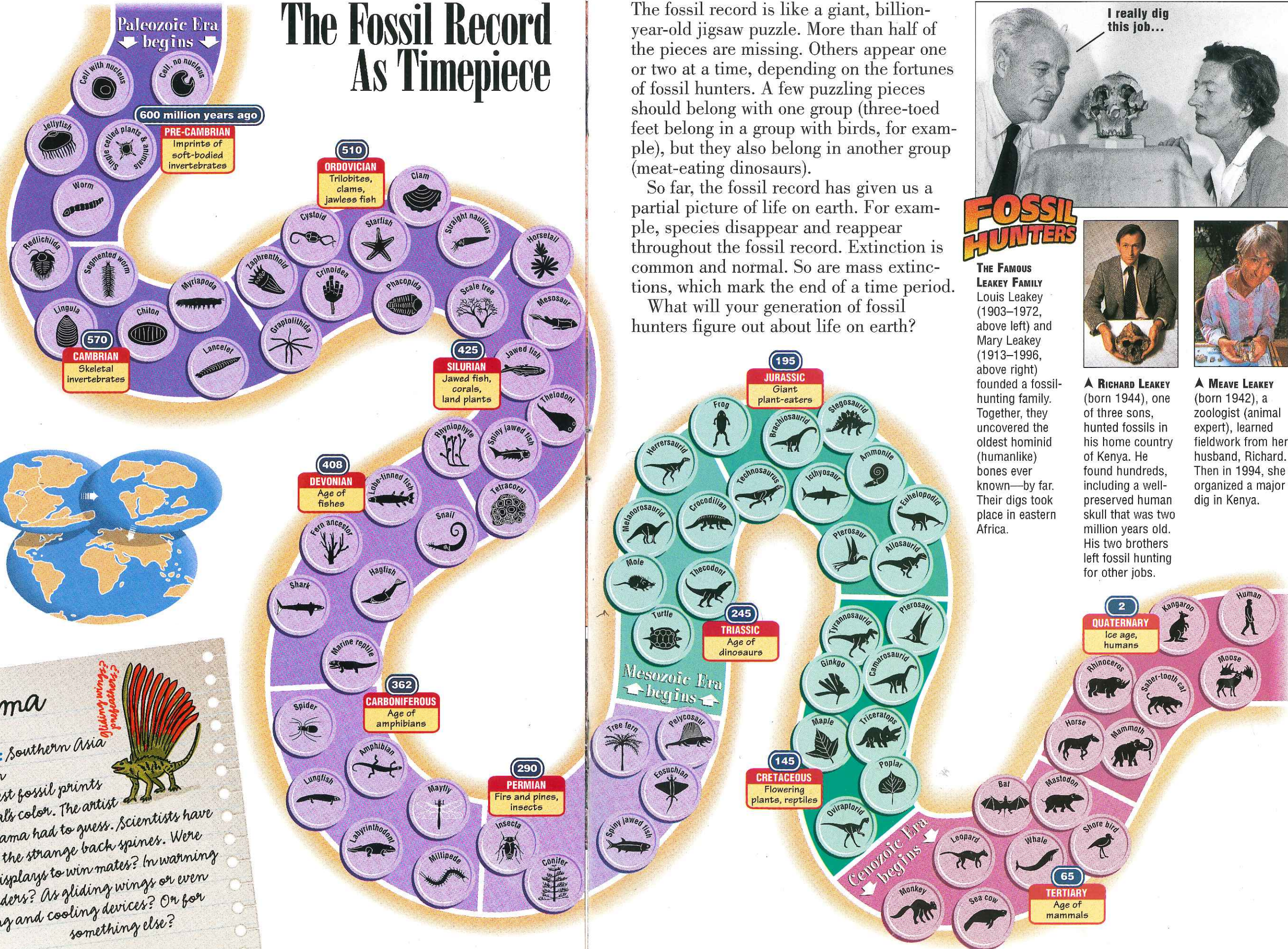
► **FOLLOW THE** curved path from the start of the Paleozoic Era—600 million years ago—through the Cenozoic Era and find out what or who lived when.

► **THE FOSSIL RECORD** is evidence that continents have drifted together and apart. For example, fossils in Massachusetts match those on the western coast of Africa. So the two land blocks must have been connected at some point. Right now, North America and Europe are drifting apart. The Atlantic Ocean increases 1.25 inches in width each year.



**Creature Feature**  
**Longisquama**  
 ("long, bony scale")  
 Time: 240 mya Place: Southern Asia  
 Close in size: Soda can  
 Fossil fact: Even the best fossil prints cannot reveal an animal's color. The artist who drew this Longisquama had to guess. Scientists have to guess the purpose of the strange back spines. Were they used in courtship displays to win mates? In warning displays to scare intruders? As gliding wings or even prefeathers? As heating and cooling devices? Or for something else?

# The Fossil Record As Timepiece



The fossil record is like a giant, billion-year-old jigsaw puzzle. More than half of the pieces are missing. Others appear one or two at a time, depending on the fortunes of fossil hunters. A few puzzling pieces should belong with one group (three-toed feet belong in a group with birds, for example), but they also belong in another group (meat-eating dinosaurs).

So far, the fossil record has given us a partial picture of life on earth. For example, species disappear and reappear throughout the fossil record. Extinction is common and normal. So are mass extinctions, which mark the end of a time period.

What will your generation of fossil hunters figure out about life on earth?



## FOSSIL HUNTERS

**THE FAMOUS LEAKEY FAMILY**  
 Louis Leakey (1903–1972, above left) and Mary Leakey (1913–1996, above right)



They founded a fossil-hunting family. Together, they uncovered the oldest hominid (humanlike) bones ever known—by far. Their digs took place in eastern Africa.

▲ **RICHARD LEAKEY** (born 1944), one of three sons, hunted fossils in his home country of Kenya. He found hundreds, including a well-preserved human skull that was two million years old. His two brothers left fossil hunting for other jobs.

▲ **MEAVE LEAKEY** (born 1942), a zoologist (animal expert), learned fieldwork from her husband, Richard. Then in 1994, she organized a major dig in Kenya.

# Fossil Hotbeds

Where can you meet a fossil face-to-face? Museums aren't the only places. Science stores, toy stores, and some bookstores have fossils. And don't forget your local jewelry store. Fossils make great rings and necklaces. In buildings constructed of limestone, you might see small fossils in the walls or floors.

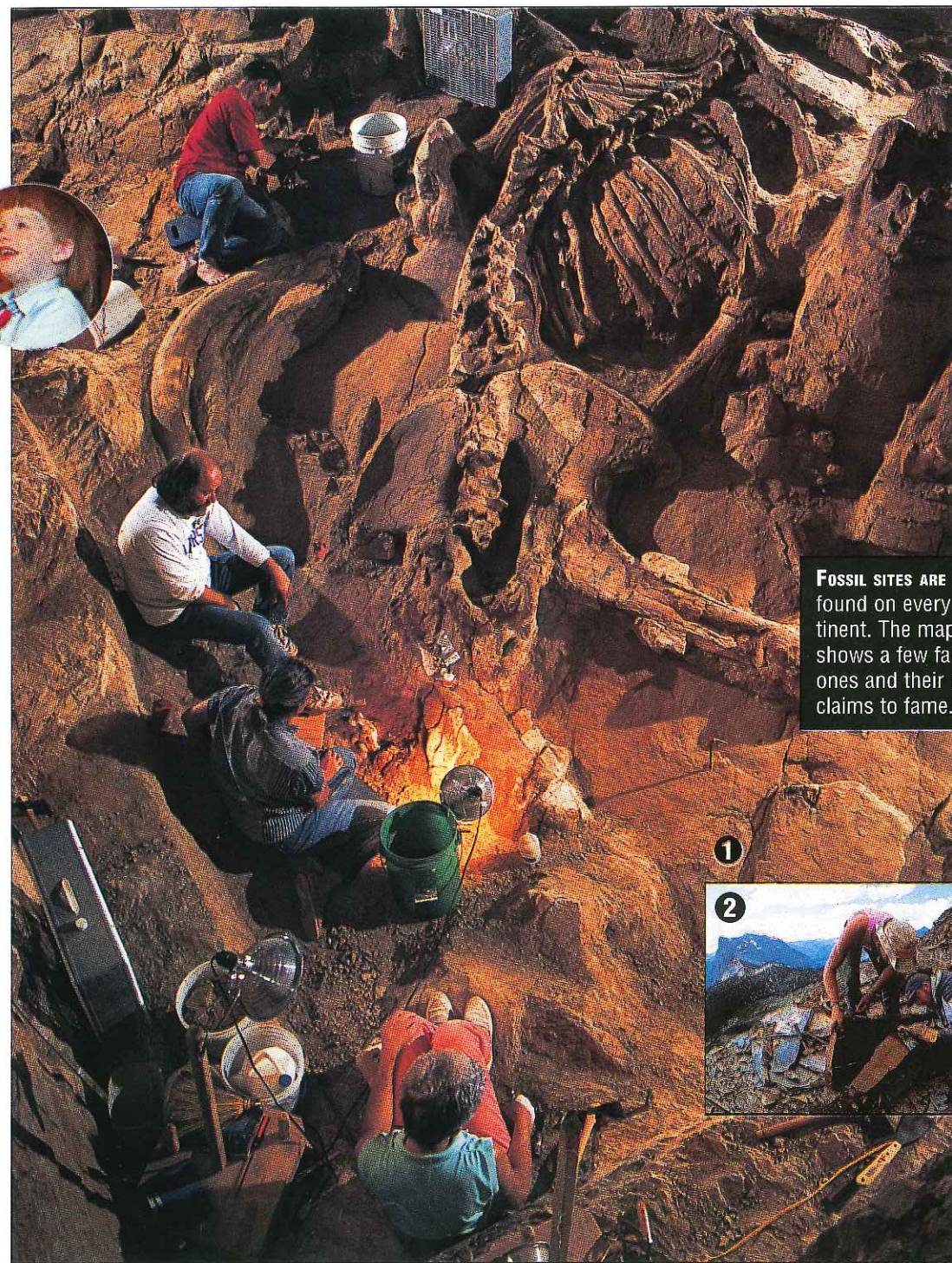
## FOSSIL HUNTERS

**DAVID SHIFFLER** (born 1992) In 1995, this three-year-old brought a 150-million-year-old into the world. While camping, young David unearthed a hard, thin green thing. He knew it was a dinosaur egg. But it took months to convince his dad. Paleontologist Emily Bray announced that it was the oldest egg of a meat eater ever found—by 80 million years.

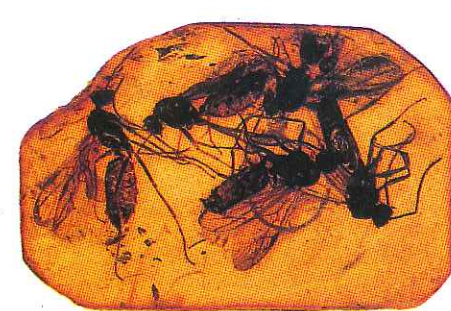
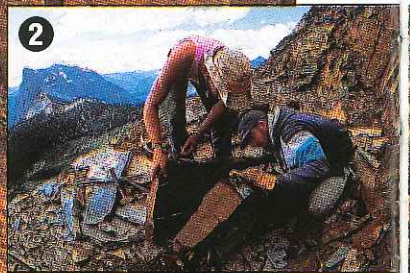


▲ **HAVE YOU EVER PUT** fossils on your face? Don't be so quick to say, "No way!" Fossil fuels such as coal and oil are formed from dead, prehistoric plants and tiny animals. Refinery products from oil and derivatives of coal are major ingredients in plastics. So wearing the latest styles in plastic sunglasses is like wearing prehistory!

Where can you meet fossils in their natural habitat? You might find specimens in your backyard or local park. Check out fossil-hunting guides or ask fossil hunters in your area. To find fossil hunters, look in *their* natural habitat—museums, rock-collecting clubs, and gem and mineral stores. As in every adventure, there are rules to follow. Be sure to seek help from an adult.

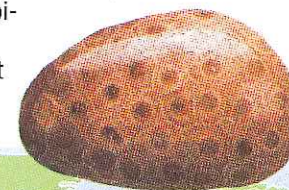


**FOSSIL SITES ARE** found on every continent. The map shows a few famous ones and their main claims to fame.



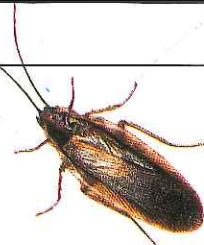
▲ **THE CREATURES** inside this clear orange case are millions of years old. The case is amber, a resin (thick, sticky liquid) that seeps

from a tree and then hardens. The amber traps any small animal—insect, spider, or even frog—that can't pull free.



▼ **PETOSKEY STONES** come from Petokey, Michigan. When dry, they look like any other great skipping stone—smooth and flat enough to hop over the water's surface. But when the stones are wet (or polished), prehistoric fossils become visible.

▲ **COCKROACHES AND** horseshoe crabs are in a sense "living fossils." Their bodies haven't changed in hundreds of millions of years. That's a sign that these prehistoric critters are well adapted to many environments.

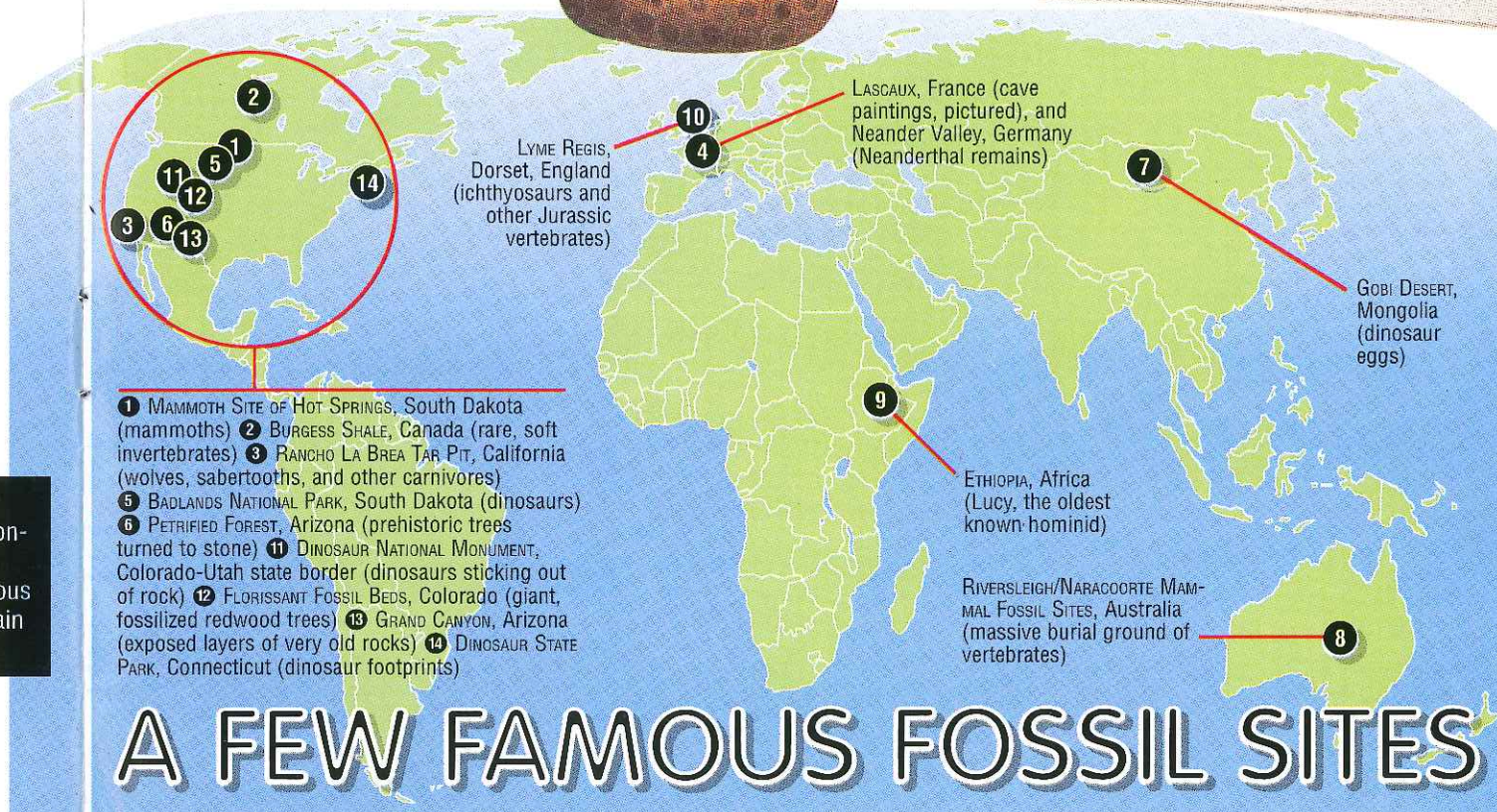


## Creature Feature Sabertooth Salmon

**Time:** 12 mya  
**Place:** Oceans

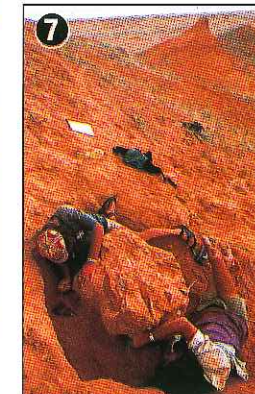
**Close in size:** Basketball hoop, including stand

**Fossil fact:** Like saber-toothed cats, these salmon used their oversized fangs to eat meat and fight foes. A trait can appear in two very different animals if they have to adapt to their environment in the same way.



- 1 MAMMOTH SITE OF HOT SPRINGS, South Dakota (mammoths)
- 2 BURGESS SHALE, Canada (rare, soft invertebrates)
- 3 RANCHO LA BREA TAR PIT, California (wolves, sabertooths, and other carnivores)
- 5 BADLANDS NATIONAL PARK, South Dakota (dinosaurs)
- 6 PETRIIFIED FOREST, Arizona (prehistoric trees turned to stone)
- 11 DINOSAUR NATIONAL MONUMENT, Colorado-Utah state border (dinosaurs sticking out of rock)
- 12 FLORISSANT FOSSIL BEDS, Colorado (giant, fossilized redwood trees)
- 13 GRAND CANYON, Arizona (exposed layers of very old rocks)
- 14 DINOSAUR STATE PARK, Connecticut (dinosaur footprints)

## A FEW FAMOUS FOSSIL SITES

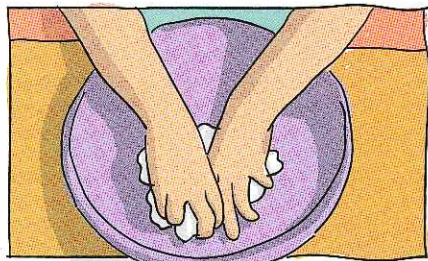


# FOSSIL IMPRINTS

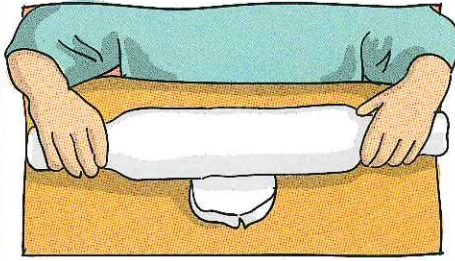
Make "fossil imprints" of leaves and other natural objects.



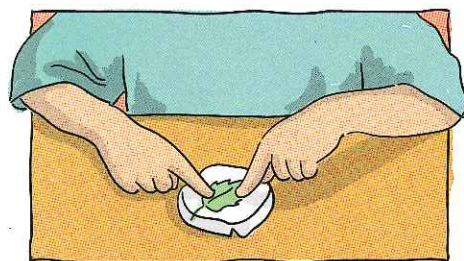
1. Mix 2 cups of flour, 1/2 cup of salt, and 3/4 cup of water.



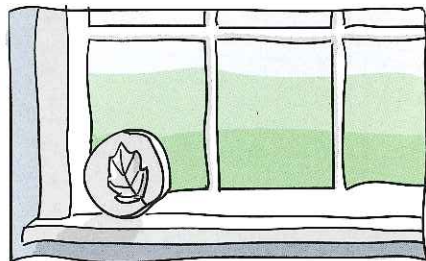
2. Knead the dough for five minutes.



3. Break off a golf ball-size chunk and flatten it on waxed paper. Press it with a rolling pin or plate to smooth the top.



4. Press a leaf into the dough and lift it out carefully.

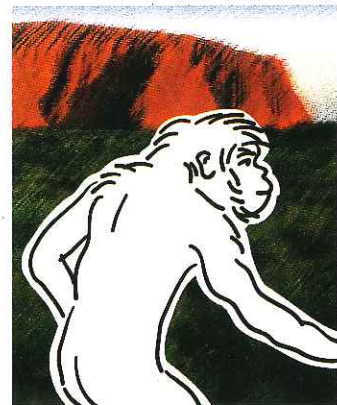


5. Let the "fossil" harden into "rock" for a day or two.

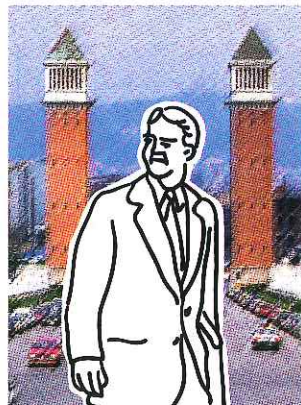
## Future Developments

From *Australopithecus afarensis* (about four million years ago) to *Homo sapiens sapiens* (today), human beings have changed a lot. What do you think will happen in the next four million years? Make a drawing that shows your idea of what humans might look like in four million years.

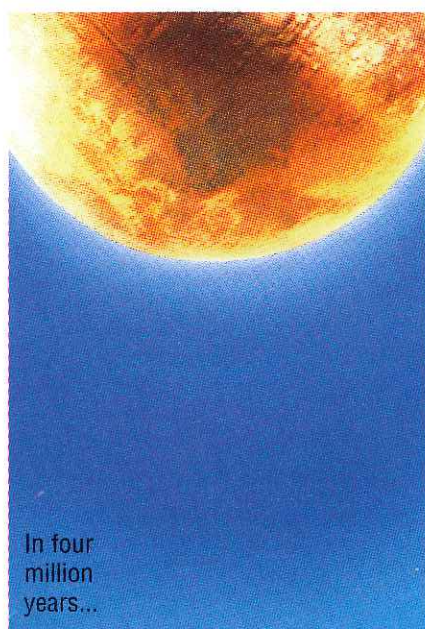
Four million years ago...



Now...



In four million years...



## Name That Fossil

Match each fossil with its fossil type (below). Put the photo number in the box next to its type.



- A. skin imprint
- B. footprint
- C. egg
- D. bone
- E. amber



## SEARCHING FOR TIME

The names of ten geologic periods and eras are hidden below. A name may be written forward or backward, up or down, or diagonally. See if you can find the following, plus one that is a secret: Cambrian, Carboniferous, Cenozoic, Cretaceous, Mesozoic, Paleozoic, Permian, Tertiary, Triassic.

Tyrannosaurus 'X'?

T	M	P	E	C	D	O	V	X	H	A	M
C	R	E	T	A	C	E	O	U	S	I	S
A	U	B	S	T	Y	O	P	J	M	E	Z
R	W	G	I	O	C	L	E	X	F	L	N
B	F	C	I	O	Z	O	N	E	C	A	A
O	U	I	T	L	I	O	A	P	I	V	I
N	T	S	E	K	C	B	I	M	H	T	R
I	R	S	P	E	U	C	R	C	Y	E	B
F	O	A	T	K	J	E	P	U	H	R	M
E	I	R	Q	U	P	O	R	T	C	T	A
B	C	U	G	T	R	I	A	S	S	I	C
O	A	J	P	W	U	V	L	C	R	A	T
U	P	A	L	E	O	Z	O	I	C	R	I
S	J	U	R	P	M	S	T	E	R	Y	L

## MORE READING ON FOSSIL HUNTERS

**CHILDREN'S RESOURCES**  
*Dinosauria On-Line* (<http://www.dinosauria.com>), an Internet information site created by Jeff Poling.  
*Dinosaurs and Things* (Aristoplay, 888/478-4263), an educational board game with three levels of questions.  
 Niles Eldredge, *The Fossil Factory: A Kid's Guide to Digging Up Dinosaurs, Exploring Evolution, and Finding Fossils*, Addison-Wesley, 1989. Includes experiments and projects.  
*Eyewitness Books: Fossil*, Knopf, 1990. Visual dictionary.  
*Great Canadian Fossil Trail* (<http://tyrrell.magtech.ab.ca/trail>), an Internet guide to the fossils of western Canada.  
 Joyce Pope, *Fossil Detective*, Troll, 1994.  
*Rockhound Information Page* (<http://www.rahul.net/infodyn/rockhounds>), a long list of Internet links, including companies that offer collecting trips.  
 Sara Stein, *The Evolution Book*, Workman Publishing, 1986. Includes experiments and projects.  
 Ray Troll and Brad Matsen, *Raptors, Fossils, Fins & Fangs: A Prehistoric Creature Feature*, Tricycle Press, 1996.

**BOOKS FOR ADULTS**  
 Derek E.G. Briggs et al., *The Fossils of the Burgess Shale*, Smithsonian Institution Press, 1994.  
 Alan M. Cvanara, *Sleuthing Fossils: The Art of Investigating Past Life*, Wiley, 1990.  
 Niles Eldredge, *Fossil: The Evolution and Extinction of Species*, Aurum, 1991.  
 Steve Parker et al., *The Practical Paleontologist*, Simon and Schuster, 1990.  
 David A. E. Spalding, *Dinosaur Hunters*, Prima Publishing, 1993.

## IT'S A MATCH!

Scientists try to "image" a creature from its fossil. How good are you at "imaging"? Draw a line from each creature to its fossil.

