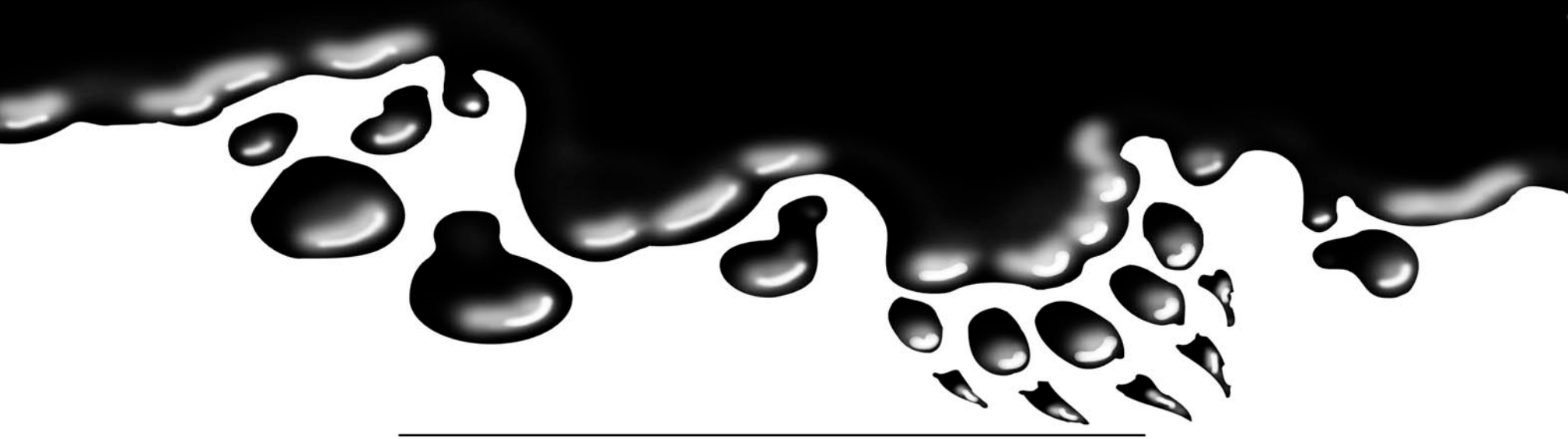
RETURN TO THE ICE AGE:
The La Brea Exploration Guide



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George C. Page Museum La Brea Discoveries
25th Anniversary ❖ 1977 - 2002

"Every time I see school buses lining the block by the museum, bringing school children from far and near, I get a deep feeling of satisfaction and I know my time and efforts were justified."

- George C. Page
1901 - 2000

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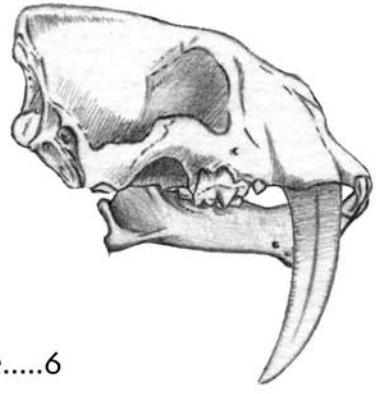

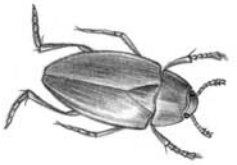

1 La Brea Geology:

2 La Brea Flora & Fauna:

3 Human Explorations & Excavations:

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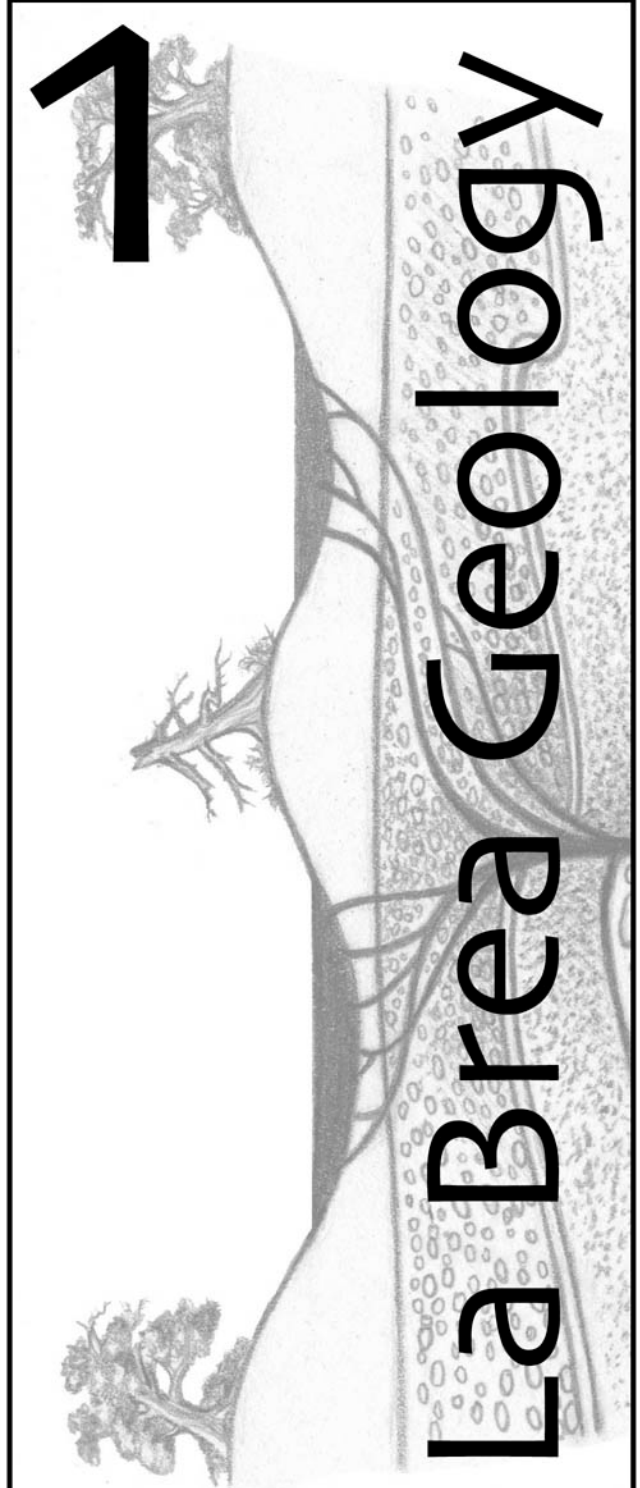


Section 1:
La Brea Geology

Section Parts:

Geologic Time; Asphalt Deposits; Entrapment Events; Fossil Burial & Preservation; Conditions of Fossilization; Microfossils & The Pleistocene Climate

Ice Age Investigations:

- When was the last great Ice Age?

- What is asphalt? Why is it not called tar?

- How does a "tar pit" form? What do these formations look like?

- How did animals become stuck in the asphalt? Did entrapment at Rancho La Brea happen often?

- What were some of the different processes that affected the bones before and after they were buried in the asphalt?

- What are microfossils? What information do they reveal about the last Ice Age?

La Brea Vocabulary:

- Asphalt
- Pleistocene
- Sediments
- Entrapment
- Microfossils
- Ice Age
- Fossil
- Erosion

Geologic Time

Era	Period	Epoch	Years Ago (Millions)
Cenozoic	Quaternary	Recent	0.01
		Pleistocene	1.8
	Tertiary	Pliocene	5
		Miocene	24
		Oligocene	38
		Eocene	54
		Paleocene	65
Mesozoic	Cretaceous		145
	Jurassic		210
	Triassic		250
Paleozoic	Permian		290
	Carboniferous		365
	Devonian		415
	Silurian		465
	Ordovician		510
	Cambrian		575
Precambrian			

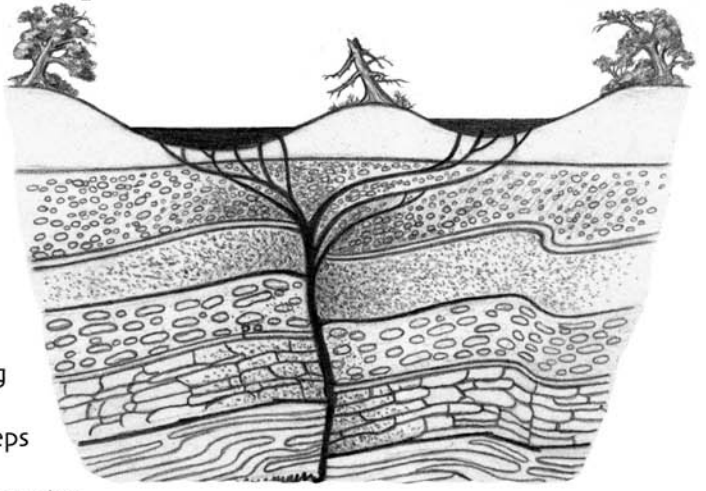
In order to be familiar with the last great Ice Age, one must understand the timeframe in which it occurred. With evidence suggesting that the Earth is 4.5 billion years old, geologists have divided the history of the Earth into units called eras. Within those eras are even smaller units of time called periods and epochs. The most recent era in the history of the Earth is the Cenozoic. Starting some 65 million years ago, the Cenozoic Era continues today. The Rancho La Brea fossil deposits began to form just 40,000 years ago, towards the end of the Pleistocene Epoch. These fossils are very recent compared to other pre-historic life forms. For instance, dinosaurs became extinct about 65 million years before the asphalt deposits or "tar pits" even began to form!

Foot Note!

If the Earth's history is represented on a 100 foot-long time line, the animals of Rancho La Brea would have lived within 1/100th of an inch (as thin a hair!) from the end of the time line.

Asphalt Deposits

Millions of years ago, the area of Los Angeles and Rancho La Brea lay beneath the surface of the Pacific Ocean. During this time, marine sedimentary layers formed and in some places these eventually became rich with fossil fuels produced from ancient sea life. When the ocean levels receded some 100,000 years ago, the area of Rancho La Brea became land. New layers of gravel, sand, and clay formed by the erosion of the emergent hills, and settled on top of the much older marine sediments full of oil.

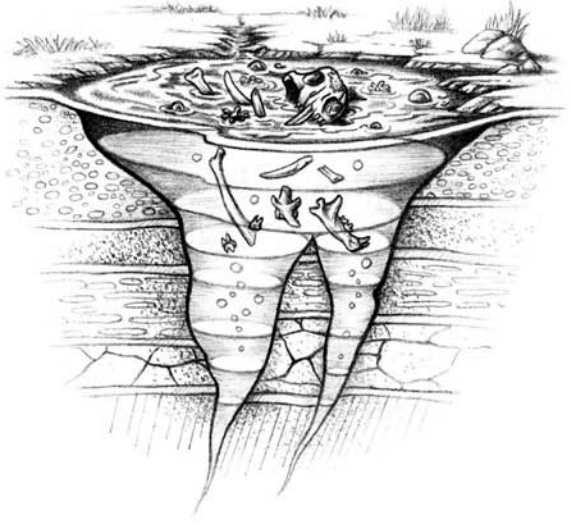


At Rancho La Brea, the crude oil has been seeping out of the ground through conduits and fissures in the coastal plain sediments for the past 40,000 years, the seeps forming pools in low-lying areas.

Fresh sediments from the surrounding hills continued to form new layers of sediments on top of the older ones and asphalt continued to seep to the surface. Over tens of thousands of years, this produced the cone-shaped asphalt deposits found at Rancho La Brea.

Foot Note!

Though asphalt seeps like those at Rancho La Brea are extremely rare, others have been found near Bakersfield, California and as far away as Peru and Iran. However, none have yielded the quantity or diversity of fossils that have been collected from Rancho La Brea.



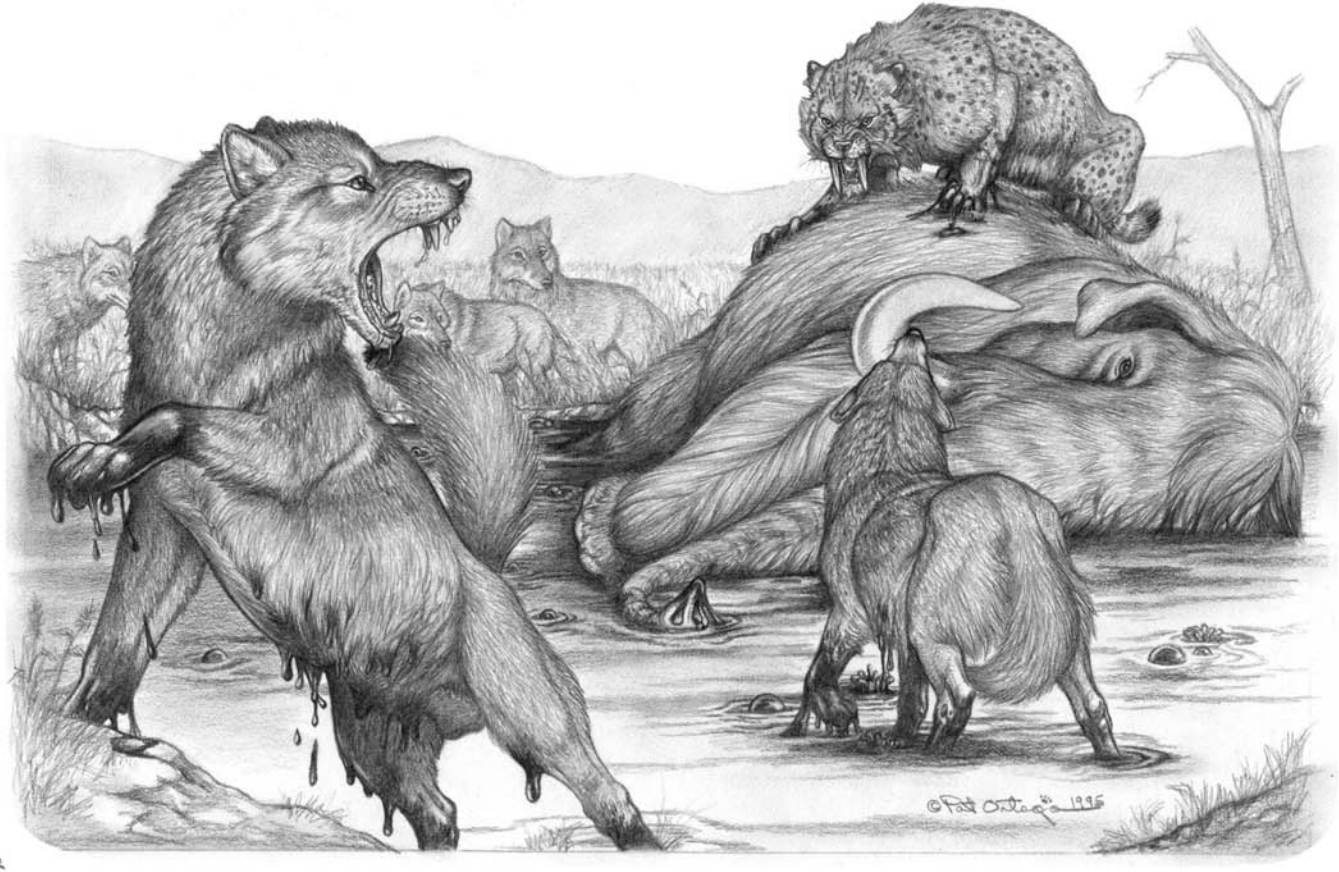
Foot Note!

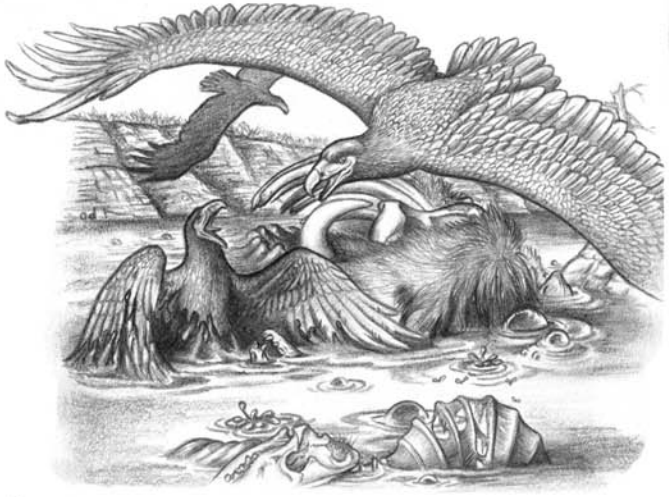
Commonly called the "tar pits," the liquids that seep out of the ground at Rancho La Brea are actually comprised of asphalt, not tar. Tar is a commercial by-product made by the distillation of woody materials, such as coal or peat, while asphalt is a naturally formed substance comprised of hydrocarbon molecules.

Entrapment Events

With its numerous asphalt seeps, Rancho La Brea was a hazardous place for animals to roam. This was especially true during the warmer seasons. As the semi-solid asphalt turned softer and stickier, leaves, dust, and water would cover the surface and partially obscure it from view.

Wandering animals would often pass by and unknowingly venture into the camouflaged asphalt. If the conditions were right, the animals might become trapped like a fly caught on flypaper. The stranded animal would be easy prey for the many carnivores that lived here.





Not likely to pass on a free meal, a pack of dire wolves or a sabertoothed cat would attack the mired animal and even each other. After an intense struggle over the helpless prey, some of the attacking predators would become trapped as well. In turn, scavengers would eat those animals and also risk entrapment.

Foot Note!
Entrapment was not a daily event. If only 10 large mammals became trapped in the asphalt every 10 years, it would more than account for the millions of bones recovered from the asphalt!

Fossil Burial & Preservation

The unusually high quality of fossil preservation at Rancho La Brea occurred because the bones were buried rapidly by the asphalt and sediments. That is not to say that the bones were buried overnight, but they were seldom exposed to elements for an extended length of time. Those that were exposed to natural processes like erosion, for an extended amount of time usually failed to be preserved as fossils.

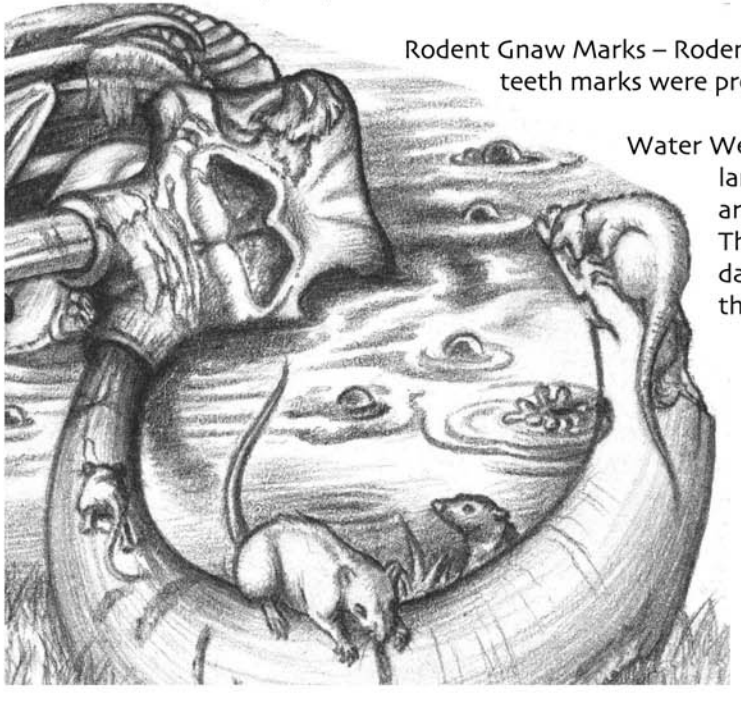
After the animal remains decayed, the bones became saturated with asphalt and partially or wholly submerged in the seep. After partial burial, winter and spring rains would wash down fresh sediments that mingled with further seepage. It is this cycle, repeated for tens of thousands of years, which contributed to the formation and composition of the fossil deposits.

Foot Note!
Animal tissues and organs such as flesh, hair, cartilage, claws, and feathers have not been recovered from Rancho La Brea. Several types of bacteria helped decompose these materials before complete burial within the asphalt and sediment layers occurred.

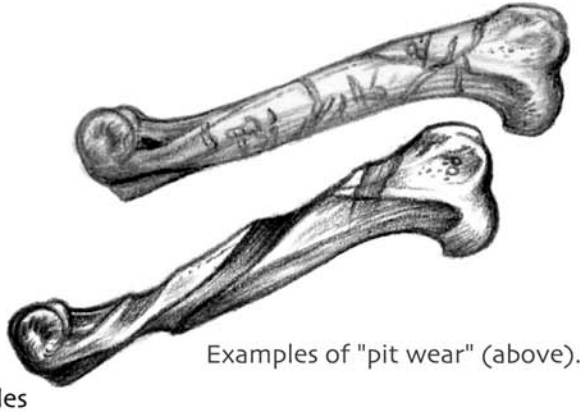
Conditions of Fossilization

Bones that were preserved by the asphalt are stained in different shades of brown. Even though the asphalt is an amazing preservative for bones, the fossils of Rancho La Brea are not always perfectly preserved. Because the bones took between several weeks and two years to be completely buried in the asphalt seeps, the bone surfaces may show:

Surface Weathering –Bones were often subjected to physical processes while on the surface. These included heat, cold, wind and rain.



Rodent Gnaw Marks – Rodents gnawed on the bones while on the surface, and their teeth marks were preserved on the fossils.



Examples of "pit wear" (above).

Water Wear – Because of the climate during the last Ice Age, larger streams and rivers were year-round in the Los Angeles area. The bones of animals that died near these streams sometimes eventually ended up in the water. The bones would then tumble downstream, bouncing off rocks and the streambed, creating the type of damage called water wear. While traveling downstream, the bones would sometimes become stuck in the asphalt that had seeped into the streambed.

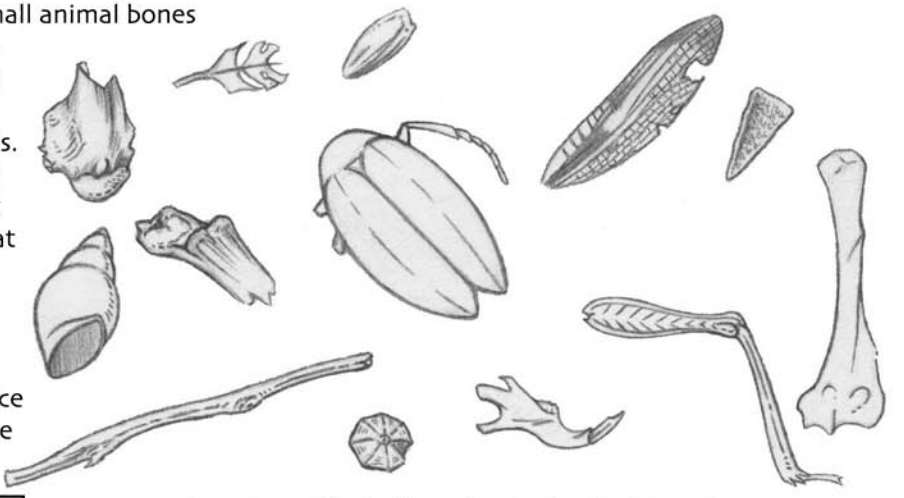
Pit Wear – Bones that have rubbed against a rock or one another within the asphalt display a condition called "pit wear." Caused by earthquakes or by animals trampling on the bones stuck in the asphalt, this condition takes the form of holes and long grooves cut in the bones.

Foot Note!
The fossils at Rancho La Brea are preserved so well that it is possible to detect healed bone fractures and subsequent infections, as well as degenerative forms of osteoarthritis and other bone diseases.

Microfossils & The Pleistocene Climate

One of the most incredible aspects of Rancho La Brea is the variety of its fossil record. The asphalt has not only preserved animal bones, but also plants, insects, and other smaller-sized specimens that are too small to be seen with the naked eye. These small objects are called microfossils. At Rancho La Brea, microfossils include freshwater shells and small animal bones that are usually identified with the aid of a magnifying glass or a microscope. These small fossils give scientists the most complete look at the environment of the Los Angeles area 40,000 years ago.

The reconstruction of the Pleistocene climate begins with microfossils. For instance, plant material is the best indicator of weather. The fossil record includes wood, leaves, cones, and seeds. The presence of chaparral-type plant life along with coastal redwood and other canyon-dwelling trees suggests that the Pleistocene climate of Los Angeles was not drastically different from the present day. In fact, the best available evidence points to a climate similar to coastal Monterey or San Francisco, California. This climate is slightly more humid and cooler than one typically associated with the present day environment of the Los Angeles area. It is a common misconception that all Ice Age climates included glaciers and ice sheets covering the landscape. This type of landscape was far away from Rancho La Brea and was nearest in the Sierra Nevada Mountains.



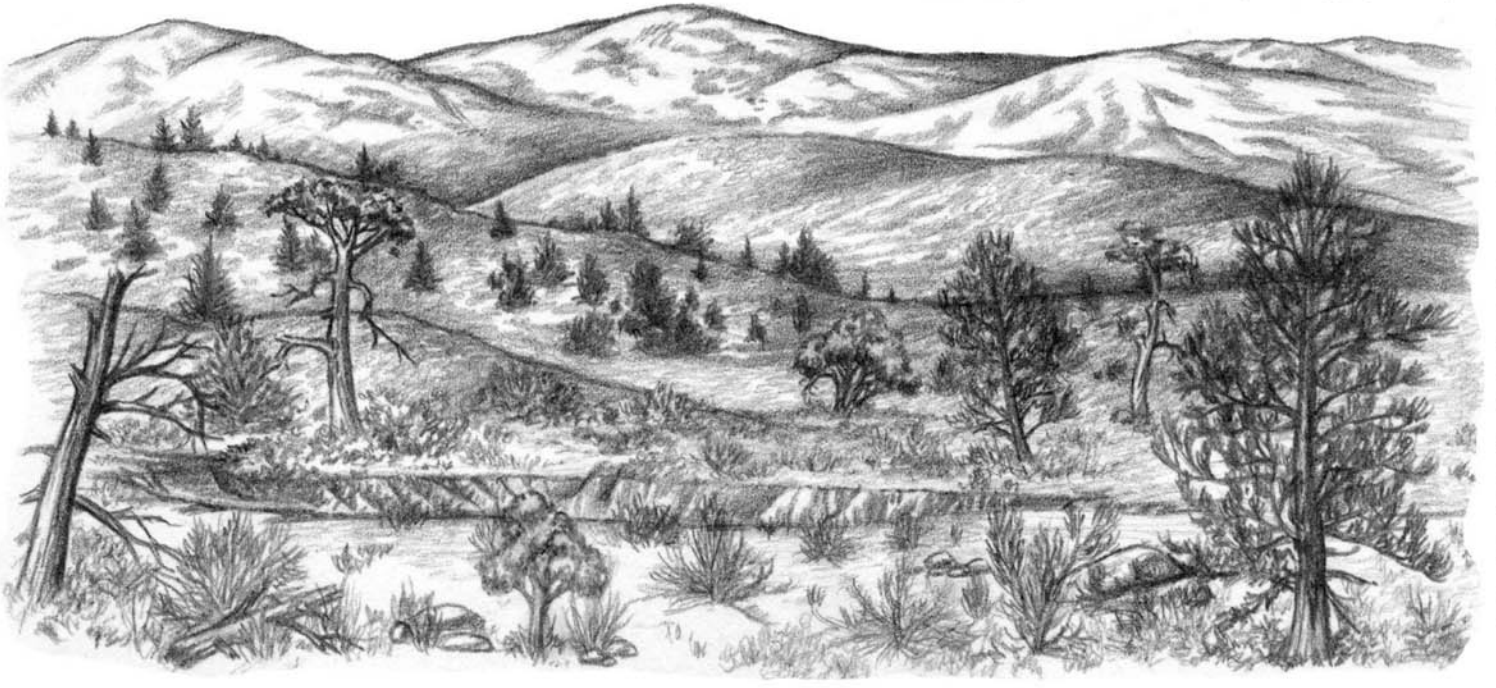
An enlarged (x3) view of microfossils (above).
For the actual size see the illustration at the bottom left of the page.

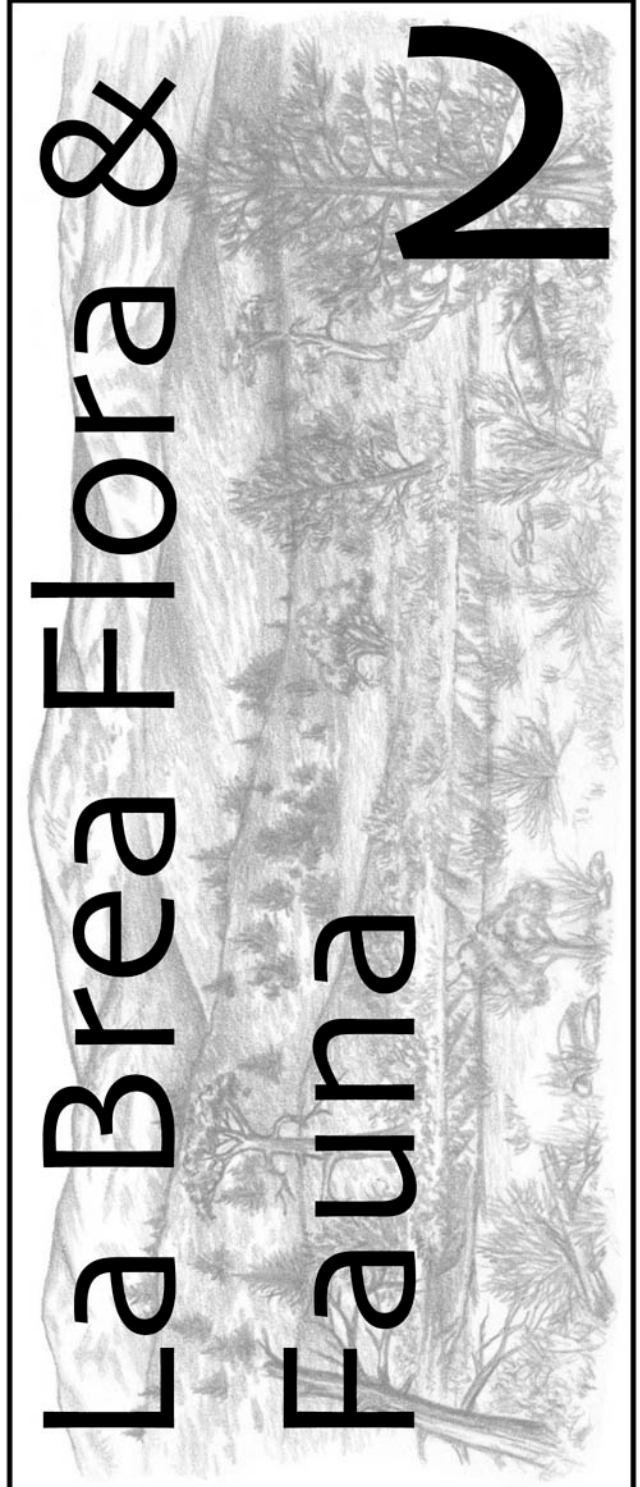
Foot Note!

Although microfossils can be very small and difficult to identify, the trained eye can easily identify deer mouse teeth from those of other rodents of the same size!

Microfossils (actual size).

The Los Angeles Basin 25,000 years ago (below).





Section 2:
La Brea Flora & Fauna

Section Parts:

Biodiversity; Plants and Their Habitats; Invertebrates; Lower Vertebrates; Birds of Rancho La Brea; Columbian Mammoth; American Mastodon; Harlan's & Shasta Ground Sloths; Western Horse & Ancient Bison; Dwarf Pronghorn & Extinct Camel; Rare Mammalian Herbivores; Dire Wolf; Short-faced Bear; American Lion; Saber-toothed Cat; Other Carnivores

Ice Age Investigations:

- What was the ecosystem of Rancho La Brea like (e.g. weather, animals, and plants)?

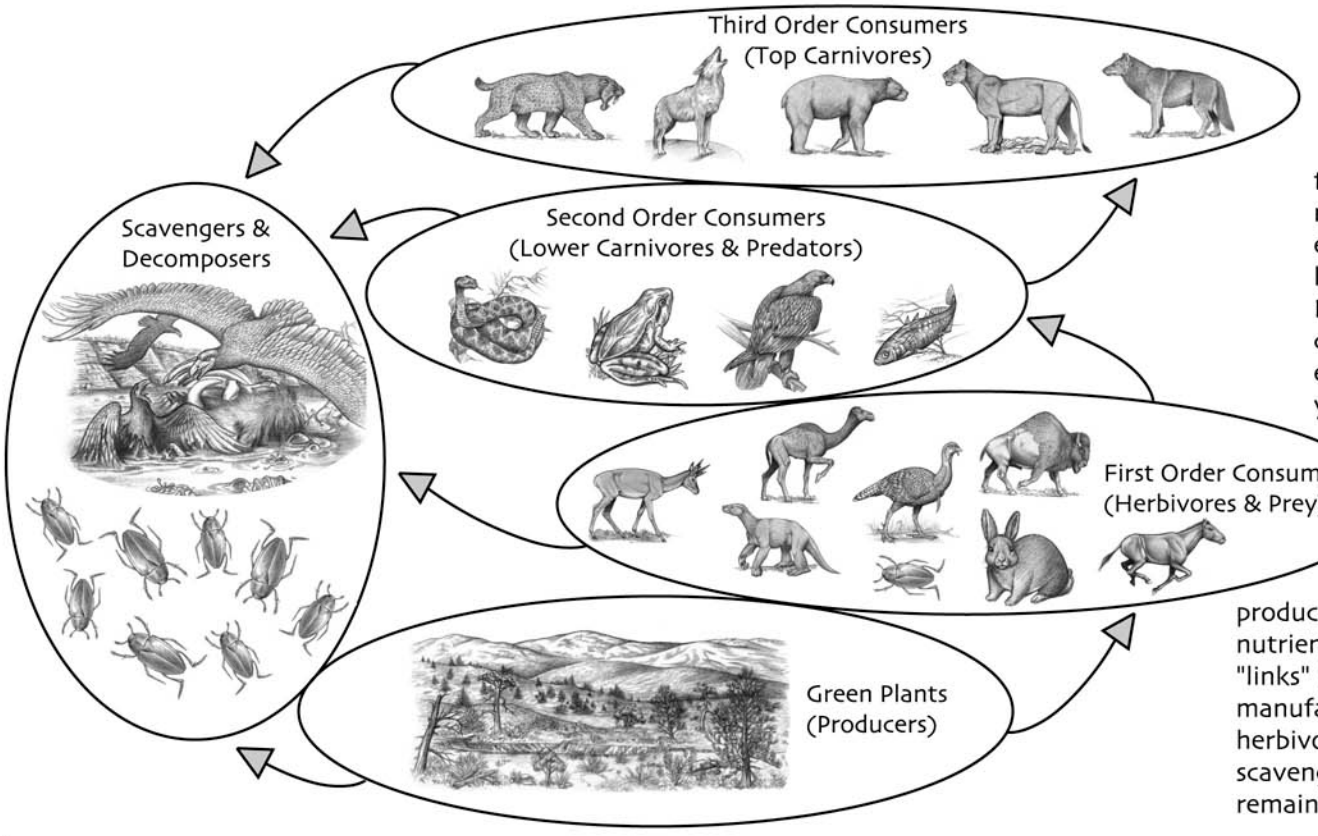
- What can the teeth of an animal reveal about its diet? What can an animal's skeleton tell us about their possible behavior?

- Do any of the animals of Rancho La Brea have living relatives? What are the similarities and differences between the extinct species and their living relatives?

- Why are some animals commonly found in the asphalt while others are so scarce?

La Brea Vocabulary:

- Ecosystem
- Environment
- Invertebrate
- Carnivore
- Feline
- Scavenger
- Prey
- Niche
- Vertebrate
- Herbivore
- Canids
- Skeleton
- Predator



Biodiversity

One of the most extraordinary aspects of the fossil deposits at Rancho La Brea is the preservation of not just a few fossils, but instead an entire prehistoric ecosystem. From the smallest plant fragments to the largest mammals, the fossilized remains of Rancho La Brea number well into the millions. The evidence is complete enough that scientists can reconstruct the environment that existed in Los Angeles 12-40,000 years ago.

Fossils from Rancho La Brea can be organized into categories according to what they ate, how they produced food and how they relate to each other. These nutrient categories are "trophic levels" in a food pyramid or "links" in a food chain. There are producers (green plants that manufacture their own food through photosynthesis); herbivores (plant eaters); carnivores (meat eaters) and scavengers and decomposers that reduce and recycle organic remains at all trophic levels.

Foot Note!

With so many species (nearly 650) represented and so many specimens (nearly 3.5 million), the collection contains large populations of plants and animals, not merely a small sample. For example, excavations have discovered thousands of sabertoothed cats, representing every age group and gender. By looking at this population and comparing the younger cats to the older ones, scientists can tell how their teeth grew and how their bones grew and fused. By looking at their healed injuries and bone infections, scientists can even start to see how they may have lived and behaved!

Plants and their Habitats

The hundreds of thousands of fossilized plant remains at Rancho La represent 158 species. Remains represent four different plant associations: chaparral, deep canyon, riparian, and coastal sage scrub.

- The chaparral plants include coast live oak, walnut, digger pine, poison oak, and California juniper.

- The deep canyon association grew in the larger and more protected canyons of the Santa Monica Mountains and contains coast redwood and other trees.

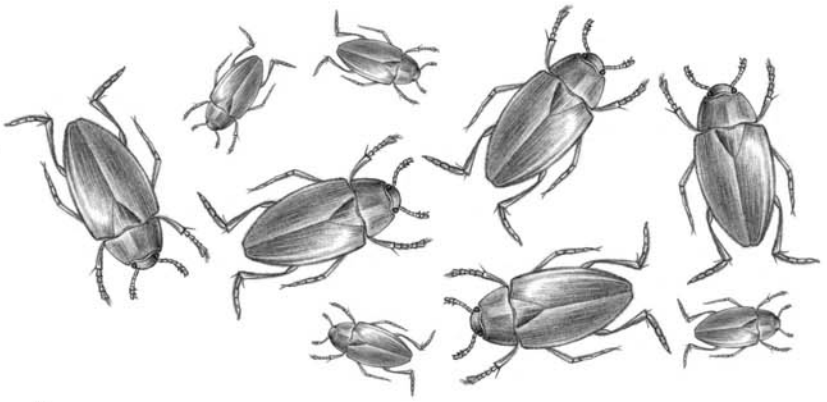
- The riparian association grew near stream margins and springs, and includes sycamore, red cedar, and raspberry.

- The coastal sage scrub dominated the coastal plain of the Los Angeles basin. It is represented by plants and trees such as sagebrush, sage, juniper, manzanita, ragweed, and thistle that did not require much rainfall.

Sagebrush (bottom right), coast live oak (below), and grasses (below right).

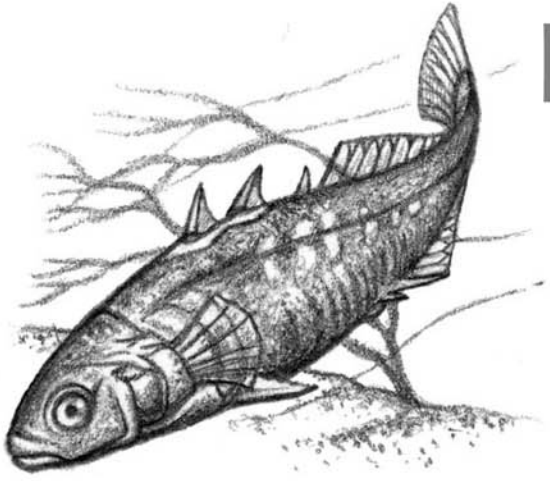
Flora

Invertebrates



Although well over a million invertebrates have been recovered from the asphalt deposits, only two species are extinct: both are kinds of dung beetles. Other invertebrates that have been identified include grasshoppers, termites, flies, scorpions, pill bugs, and water fleas.

Anthropoda & Mullusca



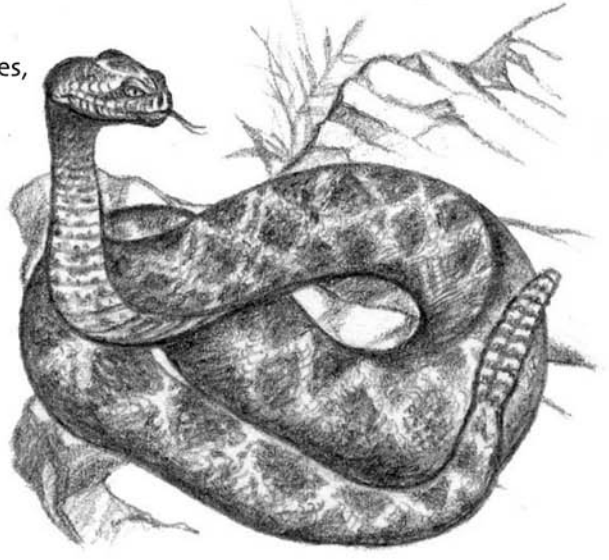
Lower Vertebrates

Thousands of reptile, amphibian, and fish remains have been removed from the asphalt deposits. Commonly called lower vertebrates, most of these animals are still found today in the southern California area.

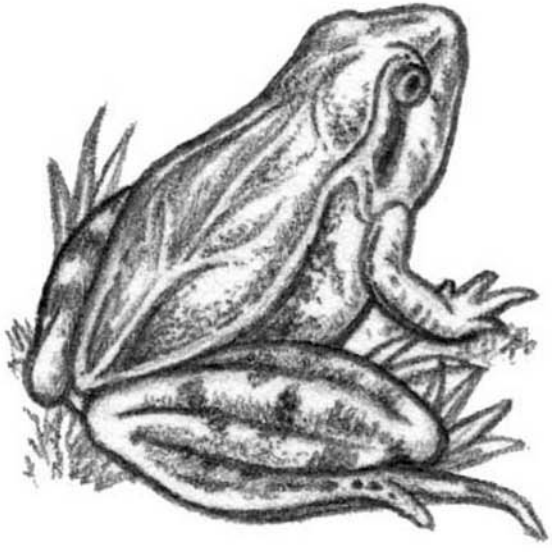
- The reptiles include the western pond turtle, gopher snake, the common king snake, two types of garter snake and the western rattlesnake.

- The western and southwestern toads, red-legged and tree frogs and a climbing salamander are the five kinds of amphibians recovered.

- Rainbow trout, arroyo chub and the three-spined stickleback are the three species of fishes recovered from the asphalt.



The fossilized remains of frogs and turtles are further evidence that suggests that the Ice Age climate was more humid than today. The three types of fishes indicate the presence of year-round streams in the area of Rancho La Brea.



Foot Note!

Small animal fossils are one of the best indicators of prehistoric ecosystems and environments. For example, a fossilized frog tells scientists that the habitat within which it lived must have been wetter because the frog was dependent on permanent water to breed. In other words, it was a captive within its environment. One scientist from the Page Museum's Laboratory put it, "The big animals just died here; the smaller animals really lived here at Rancho La Brea."

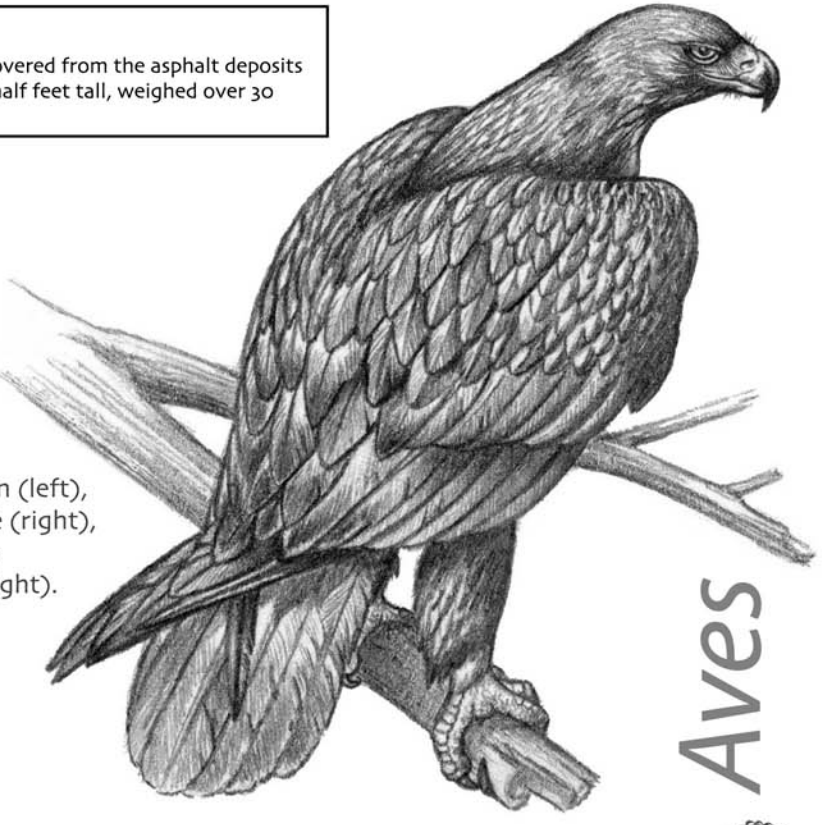
The lower vertebrates of Ranch La Brea include the three-spined stickleback (above left), frogs (left), and the western rattlesnake (right).

Reptilia, Amphibia, & Osteichthyes

Foot Note!

Merriam's Teratorn was the largest bird recovered from the asphalt deposits at Rancho La Brea. It stood over two and a half feet tall, weighed over 30 pounds and had a wingspan of over 10 feet!

The species of birds recovered from the asphalt included Merriam's Teratorn (left), the Golden Eagle (right), and the California Turkey (below right).



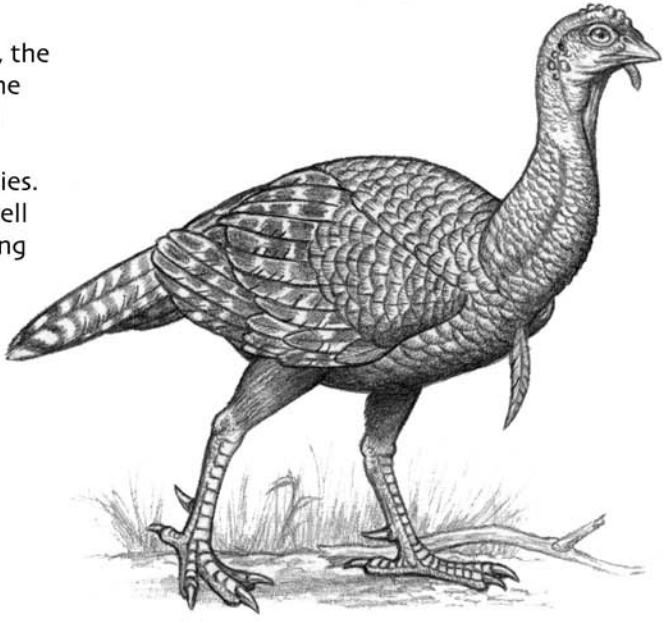
Aves

Bird fossils are very rare because their bones are hollow and quite fragile. At Rancho La Brea, however, the preservative effect of the asphalt has resulted in one of the largest collection of fossilized birds in the world. The more than 100,000 bird fossils found at Rancho La Brea include different kinds of birds of prey, waterfowl and songbirds.

Larger birds of prey, such as eagles, hawks, and falcons are represented by more than 20 different species. They include two kinds of eagles still found today in North America, the Golden Eagle and the Bald Eagle, as well as several extinct species such as Woodward's Eagle and Grinnell's Crested Eagle. These extinct eagles have living relatives that are found only in Central and South America.

Other types of birds were also recovered from Rancho La Brea. Condors and vultures were carrion feeders and direct ancestors of those still native to North America such as the endangered California Condor.

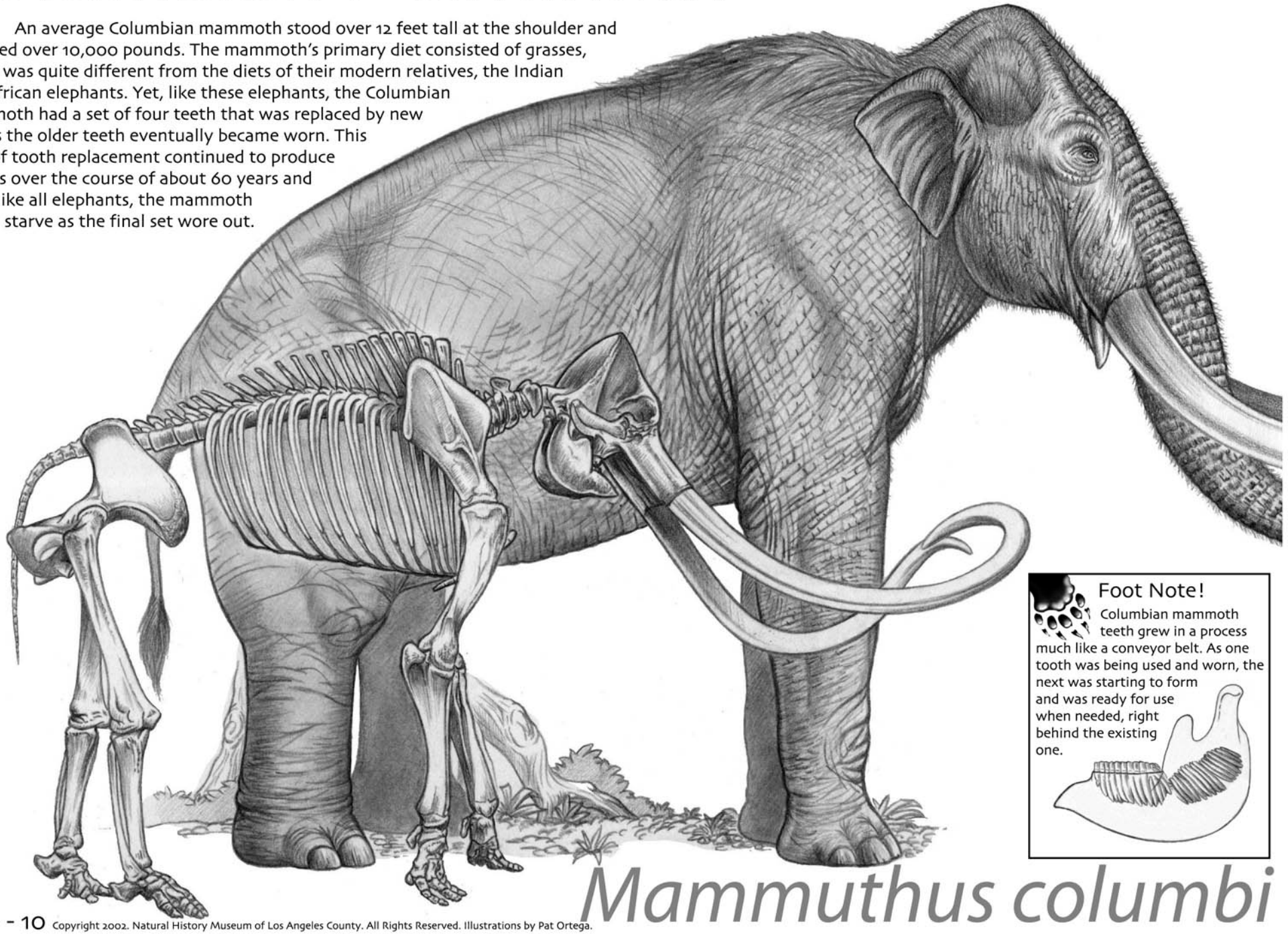
One of the most extraordinary birds found at Rancho La Brea belongs to the extinct type of birds known as teratorns. Over 100 individuals of one of these species, Merriam's Teratorn, have been discovered. These birds have a skeletal structure similar to condors. However, modern research has indicated that these birds were active predators that stalked their prey on the ground, not in the air like other birds of prey, or by feeding on carrion like condors.



Birds of Rancho La Brea

Columbian Mammoth

An average Columbian mammoth stood over 12 feet tall at the shoulder and weighed over 10,000 pounds. The mammoth's primary diet consisted of grasses, which was quite different from the diets of their modern relatives, the Indian and African elephants. Yet, like these elephants, the Columbian mammoth had a set of four teeth that was replaced by new sets as the older teeth eventually became worn. This type of tooth replacement continued to produce six sets over the course of about 60 years and then, like all elephants, the mammoth would starve as the final set wore out.



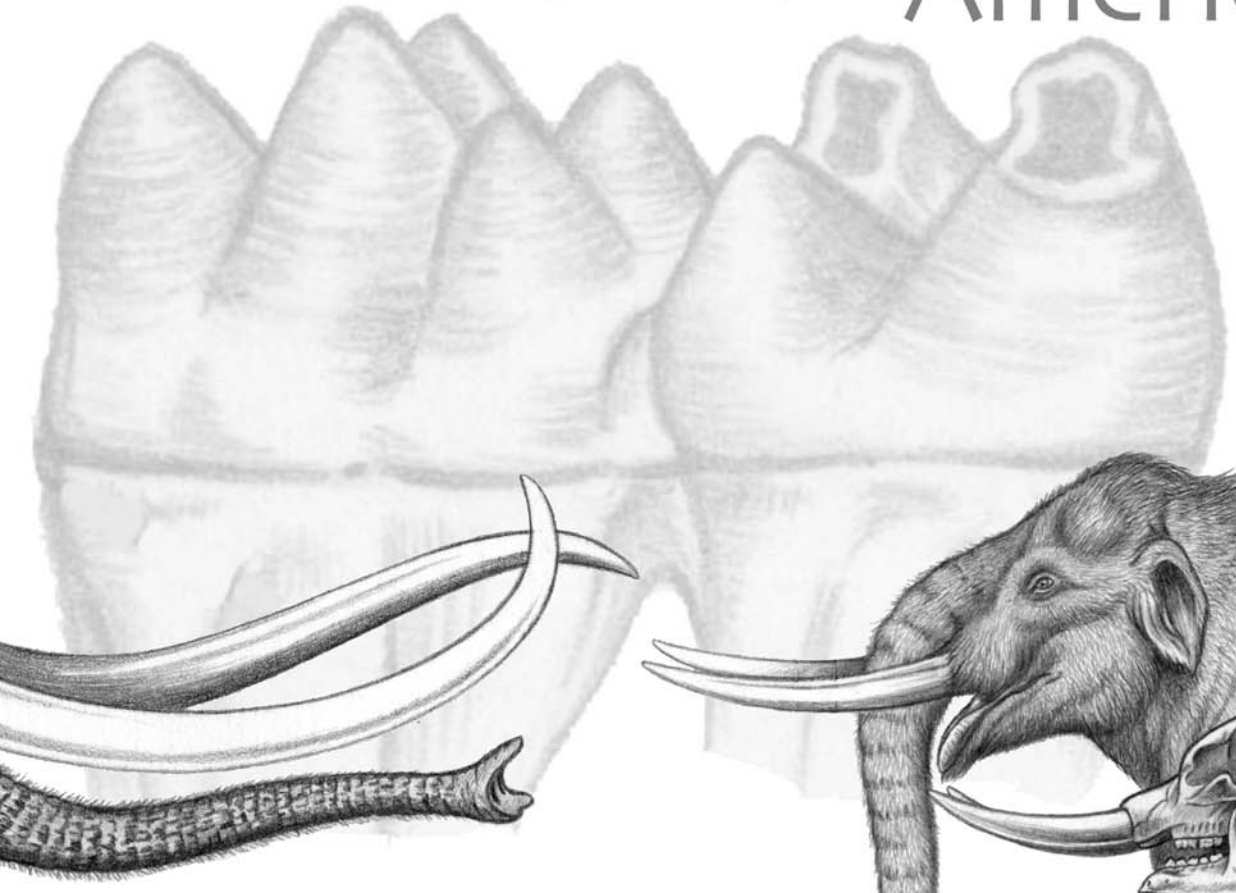
Foot Note!

Columbian mammoth teeth grew in a process much like a conveyor belt. As one tooth was being used and worn, the next was starting to form and was ready for use when needed, right behind the existing one.

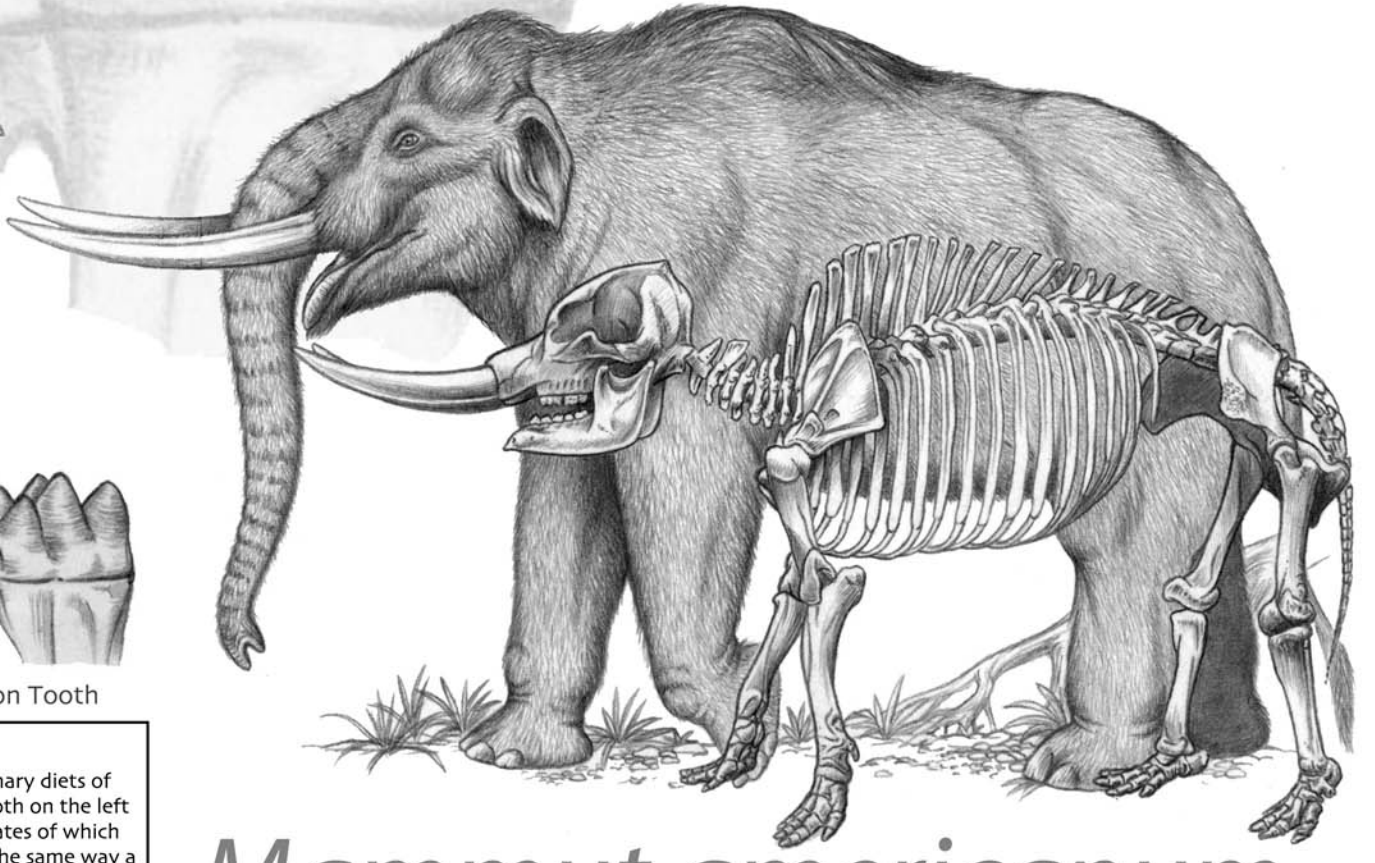
Mammuthus columbi

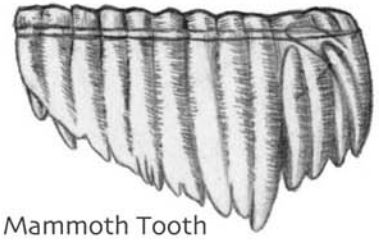
American Mastodon

The American mastodon's 3rd adult molar (below & actual size).

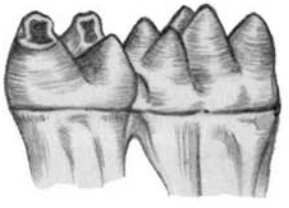


Although the American mastodon was a relative of the prehistoric mammoths, there were considerable differences between the two animals. The two major differences were the animals' sizes and their teeth. The mastodons at Rancho La Brea were roughly half the size of the mammoths and stood about eight feet tall. Although the American mastodon had the same number of teeth throughout their normal lifetime as mammoths, they had more teeth in the jaw at any one time. The mastodon's simple and low crowned teeth indicate that this animal had the diet of a browser, an animal that tends to eat leaves and twigs.





Mammoth Tooth



Mastodon Tooth

Foot Note!

Grazer vs. Browser: Scientists can usually tell the primary diets of animals by looking at their teeth. The mammoth's tooth on the left is typical for a grazer, an herbivore that eats grasses. The tall plates of which the tooth is formed act as grinding stones and chew grasses in the same way a cow does. In comparison, the ridges on the mastodon's teeth on the right are lower, typical of a browser, a herbivore that eats softer vegetation, such as twigs and leaves.

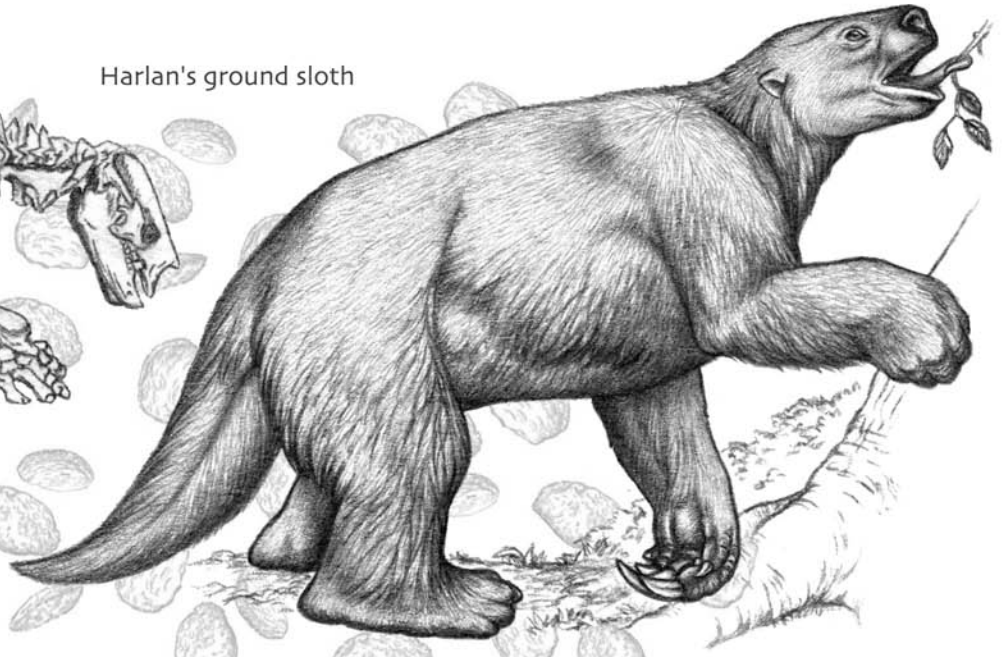
Mammut americanum

Harlan's & Shasta Ground Sloths

Paramylodon harlani & Nothrotheriops shastensis

The basic structure of a ground sloths hind (left) and front (right) limbs.

Harlan's ground sloth

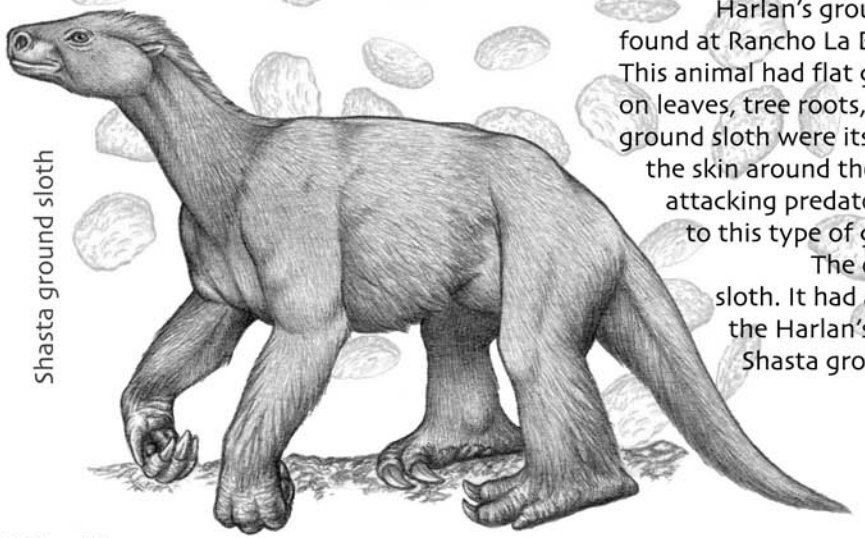


Evolving from the tree sloths in South America, ground sloths are very distantly related to anteaters and armadillos. As this animal adapted from a tree dweller to being ground-based, its limbs still showed a relationship to its ancestors. Typically, ground sloths walked on the sides of their hind feet and the backs of their forefeet.

Harlan's ground sloth was the largest and most common of the ground sloths found at Rancho La Brea. It stood over six feet tall and weighed almost 3,500 pounds. This animal had flat grinding teeth that suggest a diet of grasses, but may have also fed on leaves, tree roots, and twigs. One of the most interesting features of the Harlan's ground sloth were its skin bones, or *dermal ossicles*. These small bones were deep under the skin around the neck, shoulders and back and may have served as armor against attacking predators. They were not connected to the main skeleton and were unique to this type of ground sloth.

The other common sloth found at Rancho La Brea is the Shasta ground sloth. It had a larger tube-shaped snout and fewer teeth than its larger relative, the Harlan's ground sloth. Recent scientific findings have suggested that the Shasta ground sloth was a browser, feeding on leaves, shrubs and tree branches.

Shasta ground sloth



Foot Note!

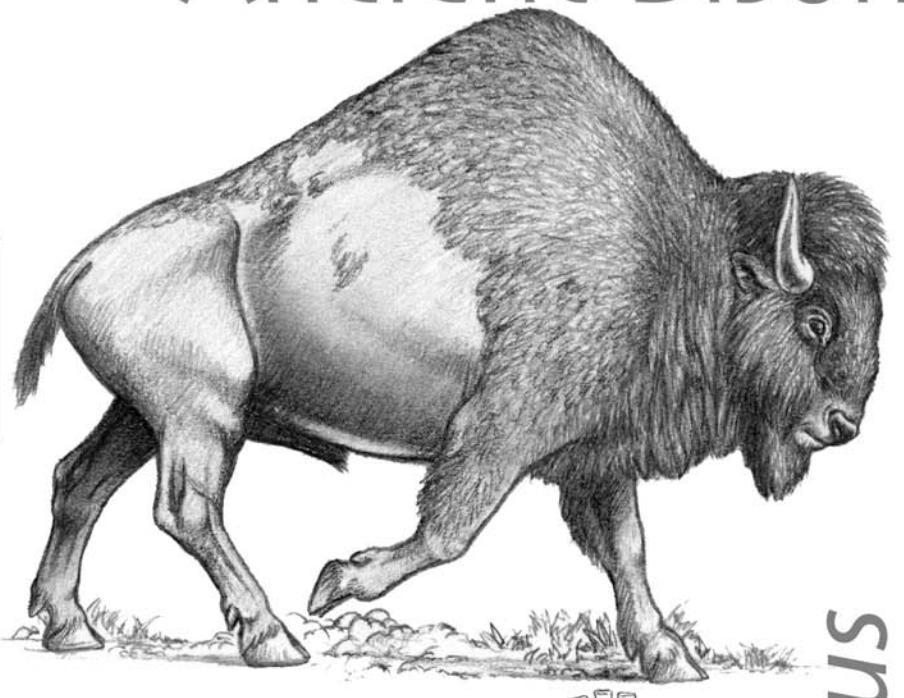
Those small lumpy "rocks" shown in the background are life-sized *dermal ossicles* of the Harlan's ground sloth.

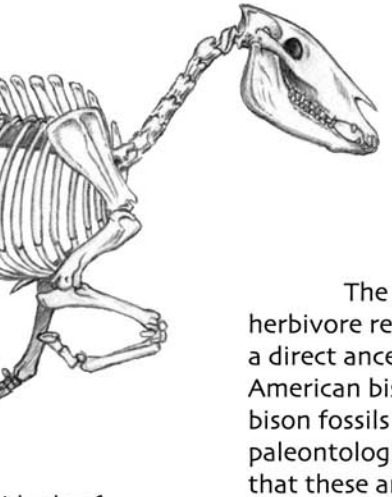
Western Horse

Ancient Bison

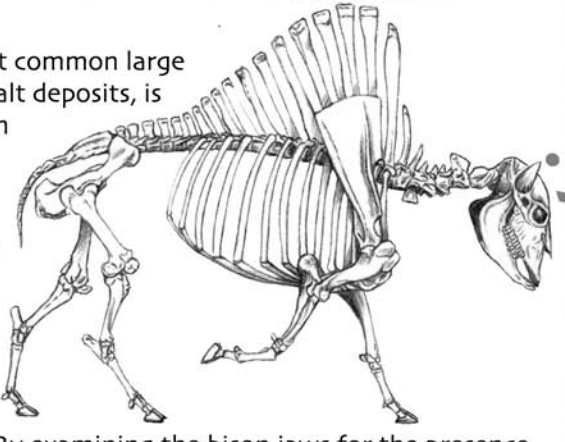
Equus occidentalis

Bison antiquus





The structure of a Western horse foot (below).



Foot Note!

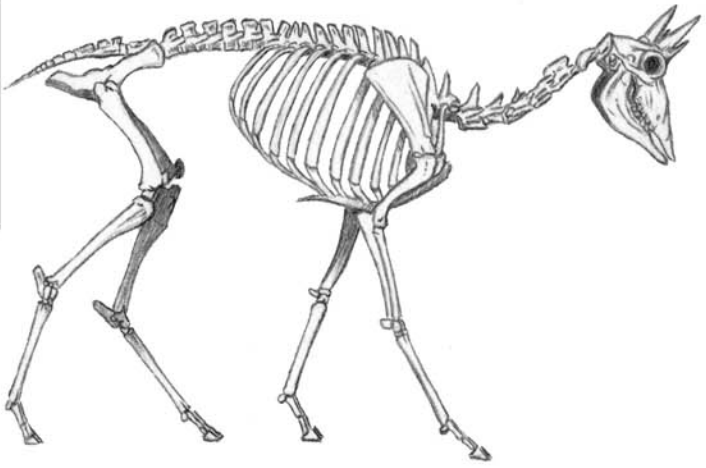
Modern bison are mistakenly called buffalo, yet are not closely related to the water buffalo of Asia or the Cape buffalo from Africa. True buffalo never migrated to North America.

With over 200 individuals of western horse recovered from Rancho La Brea, paleontologists have determined that this species had a strong resemblance to the modern East African zebra and the extinct South African quagga even though it wasn't closely related. Scientific studies on the western horse suggest that the species underwent a small, yet significant reduction in body size near the end of the last Ice Age. This change in body size may be the result of changing conditions in both climate and vegetation.

The ancient bison, the most common large herbivore recovered from the asphalt deposits, is a direct ancestor of the living North American bison. By examining the bison fossils at Rancho La Brea, paleontologists have discovered that these animals were migratory animals, similar to their modern day descendants. This conclusion was first proposed when scientists discovered that all the juvenile (young) bison within the fossil record fit into specific age groups. By examining the bison jaws for the presence of baby and permanent teeth, paleontologists concluded that all the bison found were either 2-4 months old, 14-16 months old, or 26-30 months old. No bison fossils have been found that do not fit into this annual pattern. This pattern indicates that bison were at Rancho La Brea for only a few months at a time. If the calves of ancient bison were born in early spring like their modern day relatives, then the bison would have traveled through the area each year during late spring.

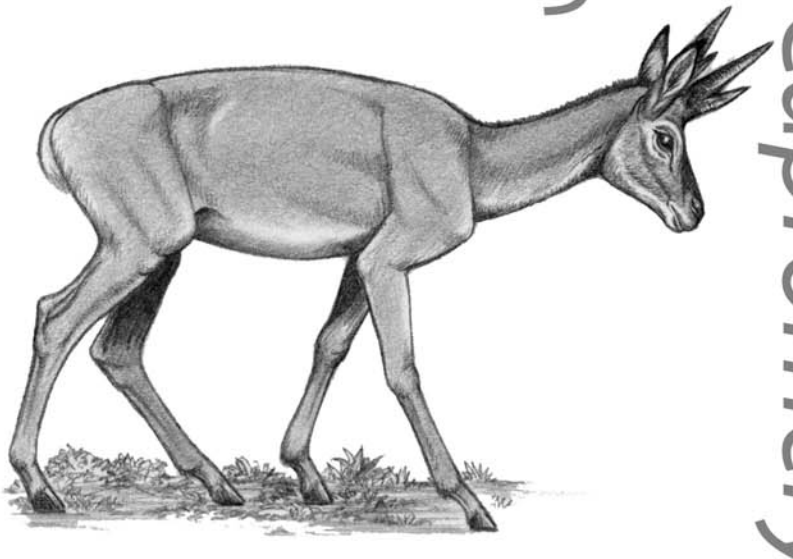
Dwarf Pronghorn

Capromeryx minor



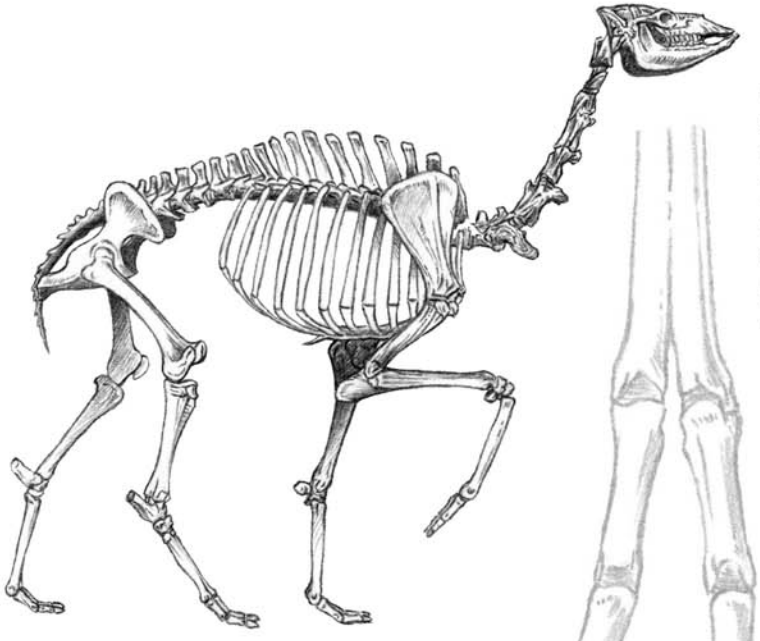
Foot Note!

Living pronghorns have been credited as the fastest land animal over sustained distances. They can run at speeds up to 40 m.p.h. (65 km/h) for several miles!



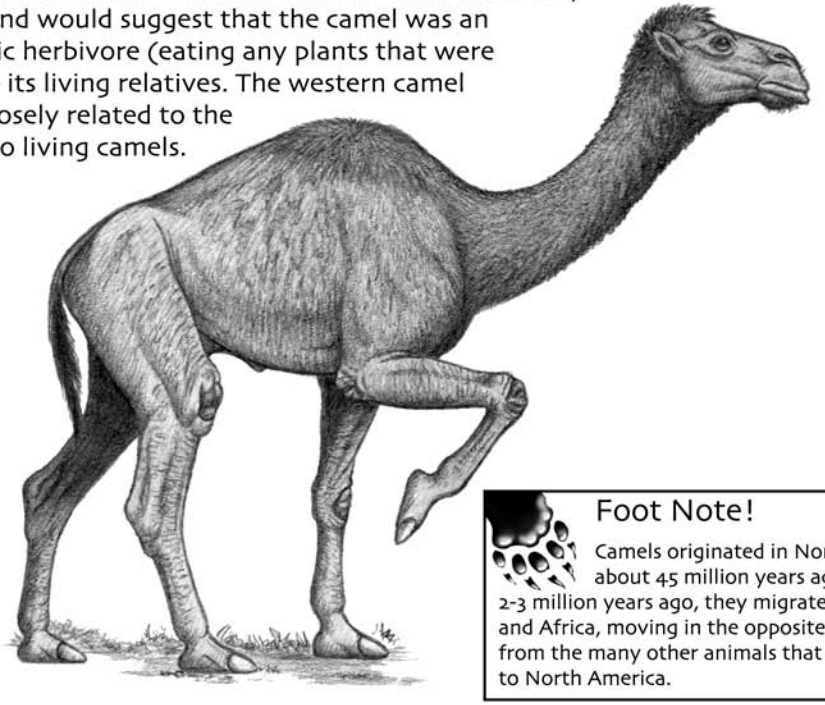
Standing only two feet tall, the dwarf pronghorn was one of the smallest ruminant herbivores found at Rancho La Brea. The dwarf pronghorn was superficially similar to modern day pronghorns, but was smaller and had horns with two distinct prongs, instead of one.

Camelops hesternus



The basic structure of a camel's foot (right).

The western camel had a very similar build to the living bactrian (two-humped) camel, but was slightly taller (standing seven feet at the shoulder) and may have lacked humps. Although its teeth suggest a diet of grasses, plant remains extracted from its teeth show very little grass and would suggest that the camel was an opportunistic herbivore (eating any plants that were around) like its living relatives. The western camel was more closely related to the llama than to living camels.



Foot Note!

Camels originated in North America about 45 million years ago. About 2-3 million years ago, they migrated to Eurasia and Africa, moving in the opposite direction from the many other animals that migrated to North America.

Extinct Camel

Rare Large Mammalian Herbivores

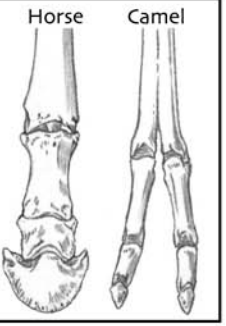
Animals like the tapir, llama, and peccary are some of the more notable rare large mammal herbivores at Rancho La Brea and are mainly represented by just a few bones.

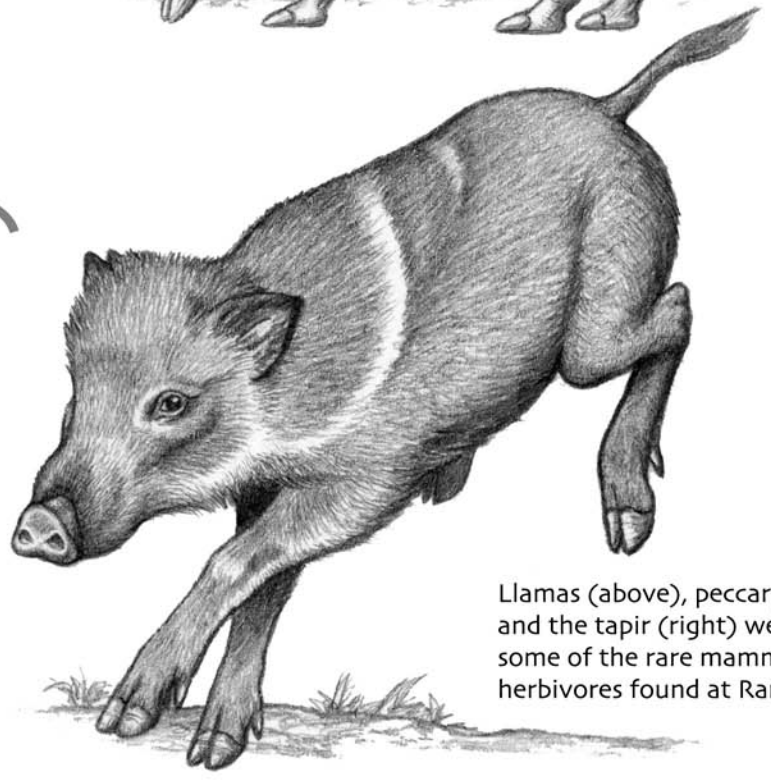
The three-toed tapir is a distant relative of modern horses. Living tapirs are found in South Asia and South America. The remains of tapirs are extremely rare at Rancho La Brea, but their presence points out that the fauna of Rancho La Brea was quite diverse.

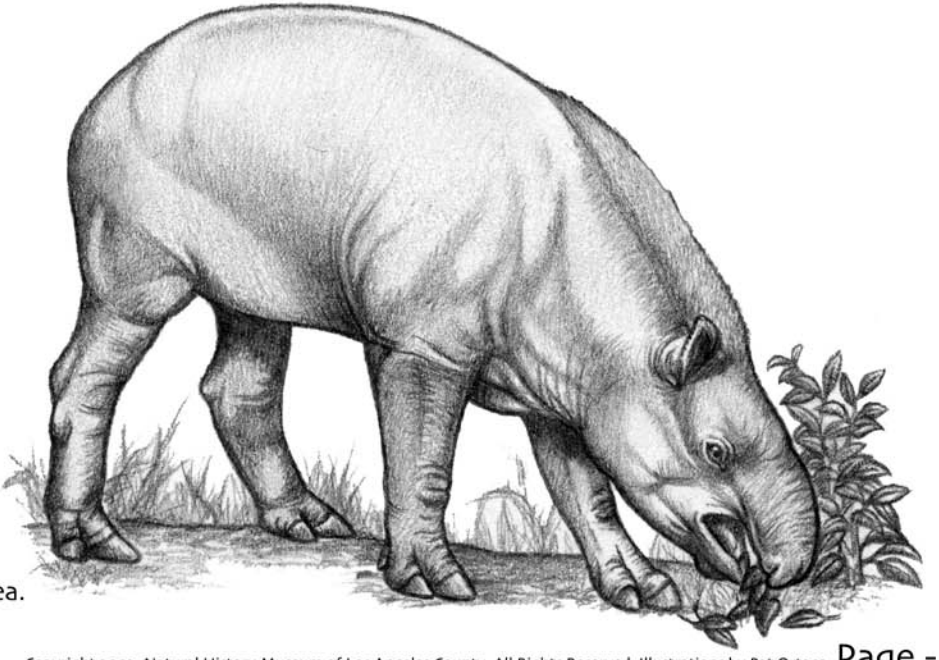
The llama and peccary are also very rare in the fossil record of Rancho La Brea. Their modern relatives, like those of the tapir, are still found in different parts of the modern world. The llama, a member of the camel family, is represented by only a few bones. Modern relatives of the llama are still found in South America. Peccaries are still widespread, ranging from the southwestern United States to South America.

Foot Note!

Many of the large herbivorous mammals found at Rancho La Brea belong in two different groups: perissodactyla (periso-dak-tilla) and artiodactyla (artio-dak-tilla). The perissodactyla are commonly called "odd-toed ungulates" and the artiodactyla are "even-toed ungulates." Ungulates are mammals that have hoofs or are the descendants of prehistoric mammals that formerly had hooves. The western horse and extinct camel limbs to the right show that although these animals are similar in many ways, there are significant skeletal differences between them.





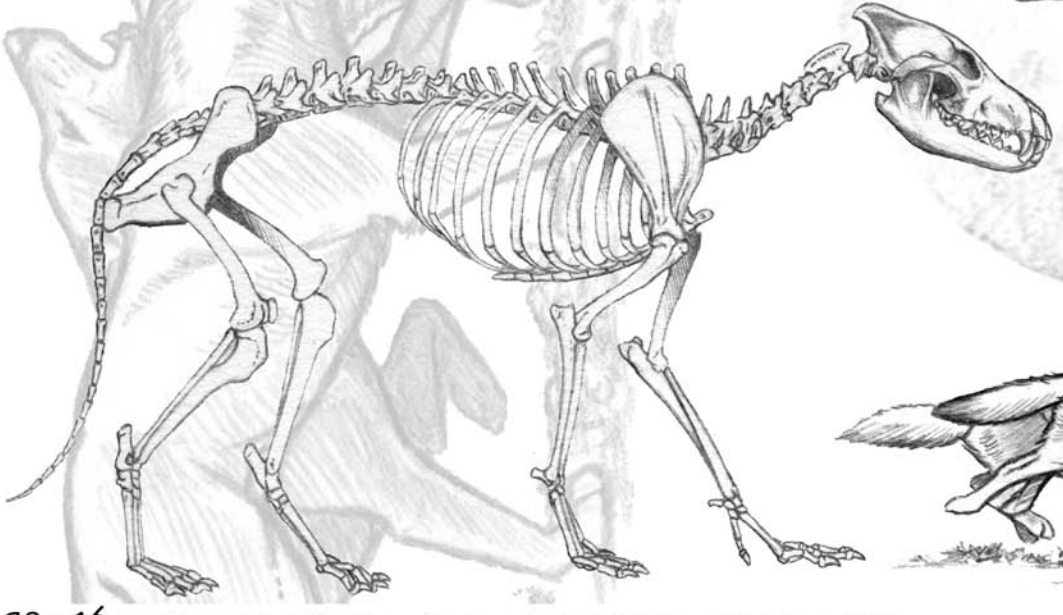


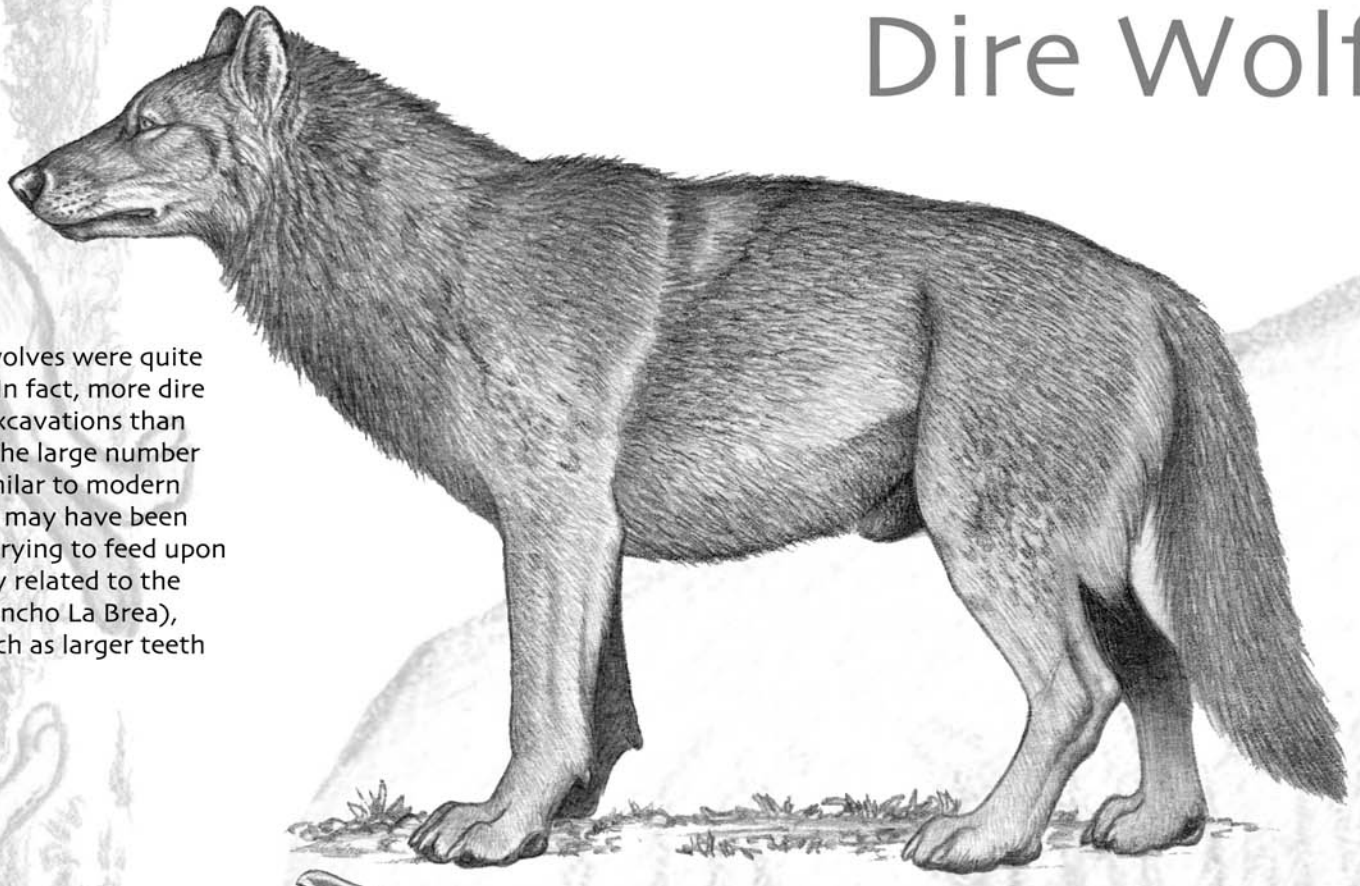
Llamas (above), peccary (left), and the tapir (right) were just some of the rare mammalian herbivores found at Rancho La Brea.

Dire Wolf

Canis dirus

During the last Ice Age, dire wolves were quite common in the Rancho La Brea area. In fact, more dire wolf fossils have been found during excavations than those of any other mammal species. The large number suggests that these fierce animals, similar to modern wolves and dogs, hunted in packs and may have been caught in the asphalt together while trying to feed upon other animals. This wolf is very closely related to the modern timber wolf (also found at Rancho La Brea), but had slight physical differences, such as larger teeth and shorter limbs.





Foot Note!

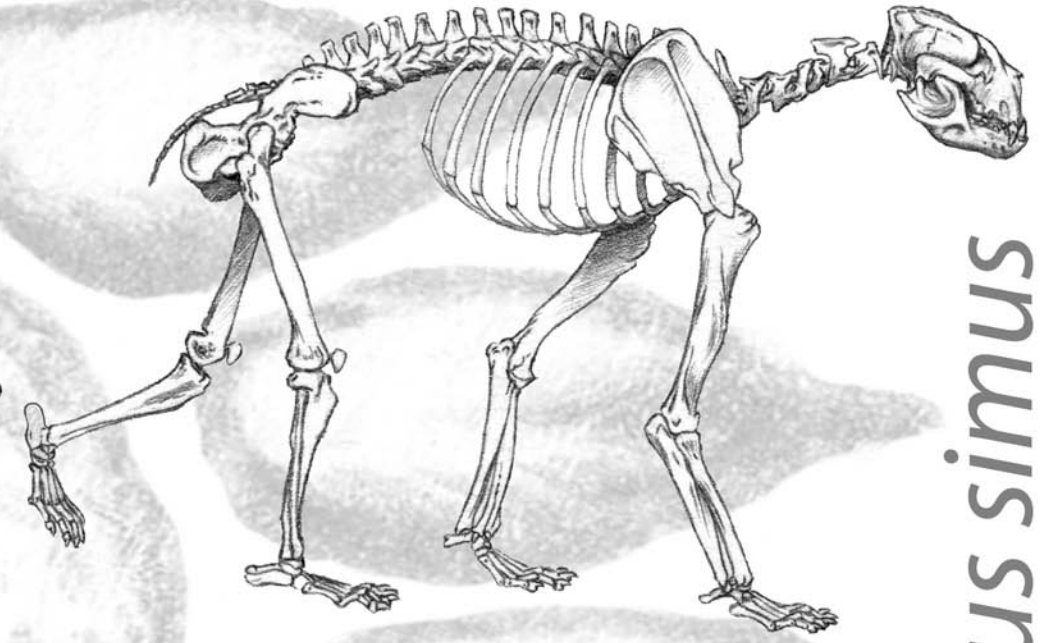
Some dire wolf bones show healed injuries. Living wolves have very similar injuries resulting from being kicked or stepped on during the pursuit of larger prey animals, such as moose and deer. Dire wolves may have become injured in much the same way while chasing ancient bison or horses.

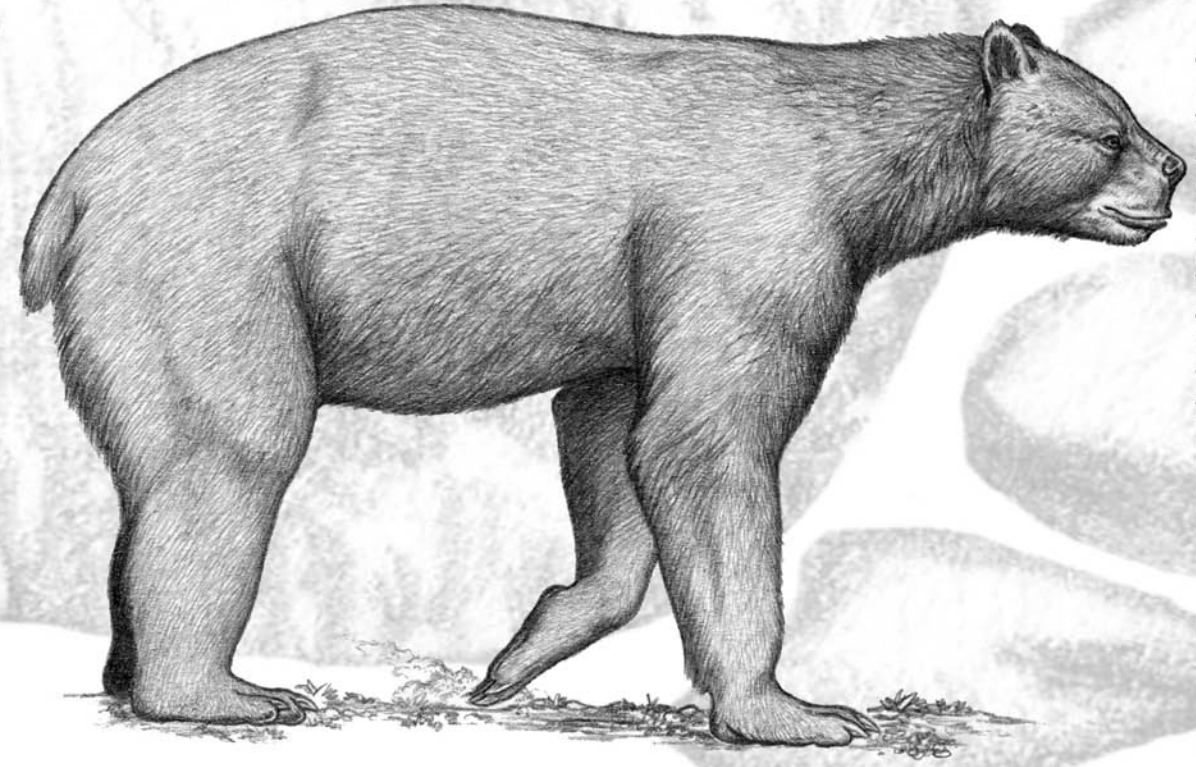
(The Short-faced Bear paw continued from the next page.)

Short-faced Bear

Arctodus simus

The short-faced bear's size in comparison to the modern day grizzly (front) and polar bear (middle).





The short-faced bear was the largest and most powerful carnivore found at Rancho La Brea. Its size alone was probably enough to scare away any opposing animal. This bear stood over five feet tall at the shoulder, making it larger than the modern grizzly, brown, and polar bears of North America. When standing upright, the short-faced bear was over 11 feet tall and could weigh as much as 1,800 pounds. Its teeth suggest that this bear, like the modern grizzly or brown bears, was an omnivore with a diet dependent on food that was available.

Foot Note!

The giant paw in the background is the same size as the female's rear foot currently on display at the George C. Page Museum. An adult male short-faced bear would have a paw approximately 25% larger!

American Lion

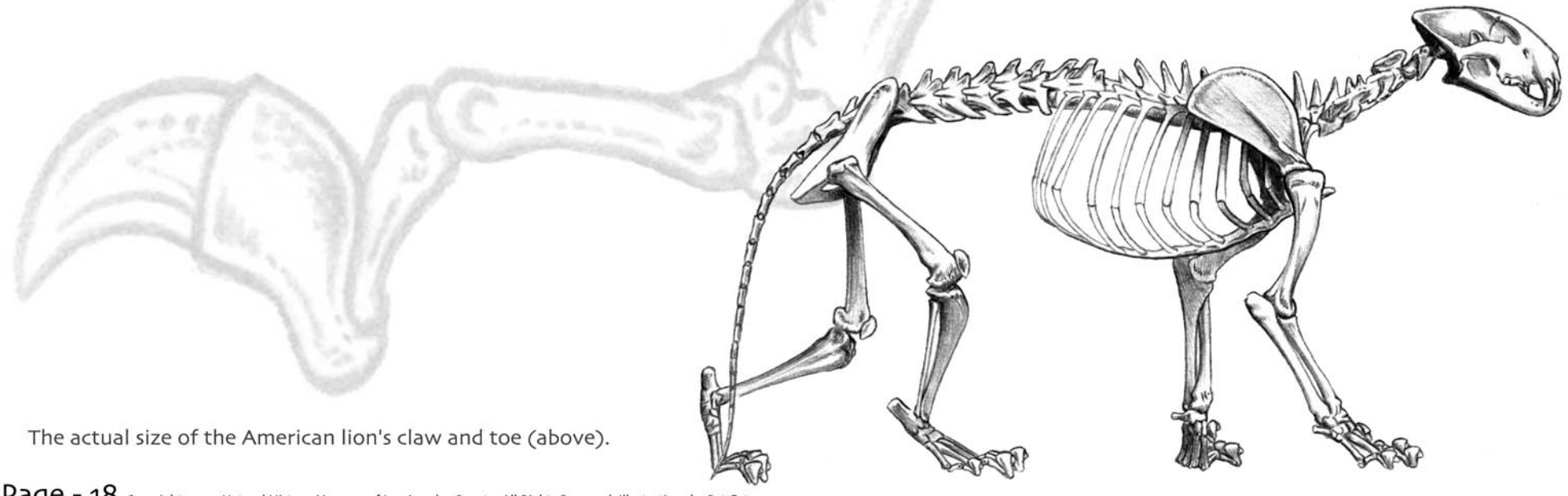
Panthera atrox

Closely related to the modern African lion, the American lion was the largest member of the cat family found in the asphalt deposits. Its enormous size just begins to shed light on the nature of this extinct predator. Like modern felines, the American lion had a tail that was about as long as its torso—roughly four feet. The tail was used to help maintain balance and direction while chasing its prey, especially in the open ground like prehistoric Rancho La Brea.

Foot Note!

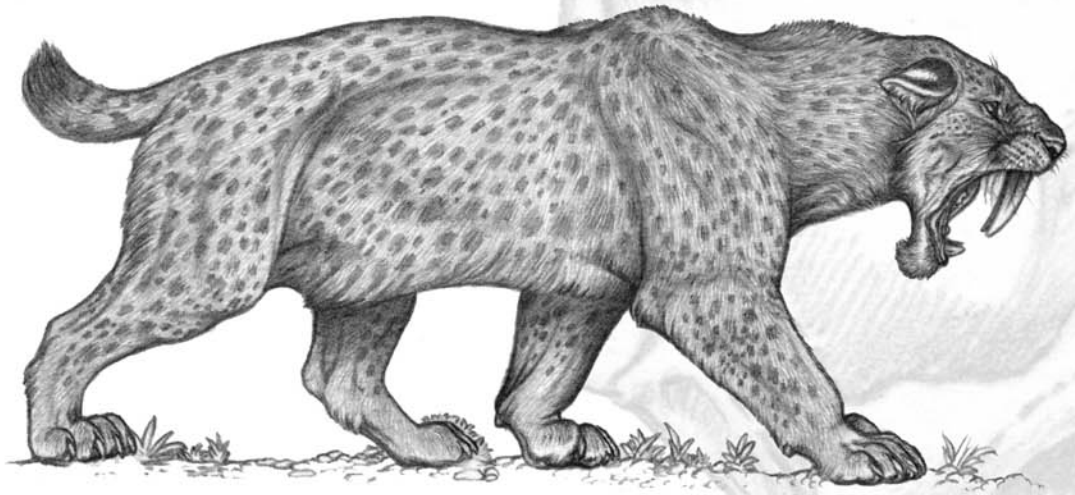
Some paleontologists see the American lion so closely related to the African lion that they have placed the two animals in the same species.

American lion (*Panthera atrox*) ----> *Panthera leo atrox*
African lion (*Panthera leo*) ----------> *Panthera leo leo*

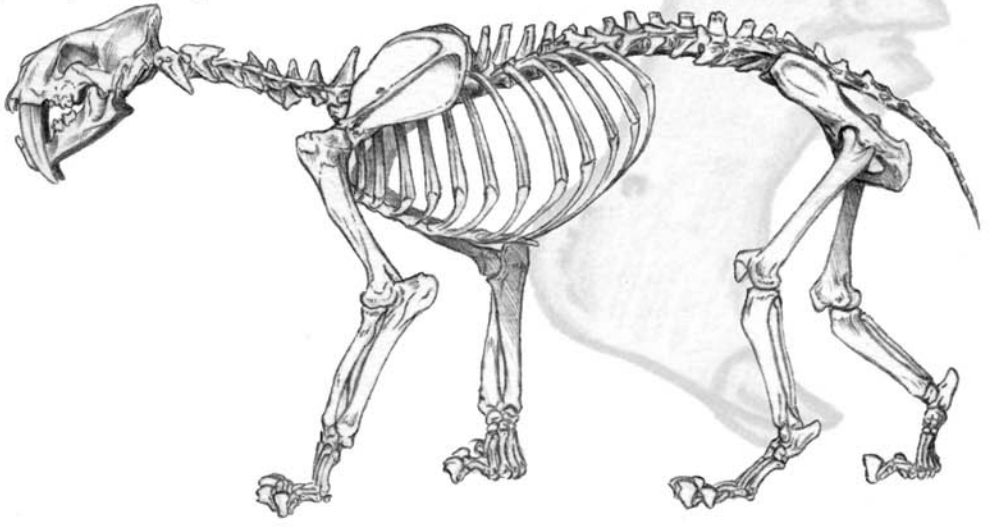


The actual size of the American lion's claw and toe (above).

Smilodon fatalis



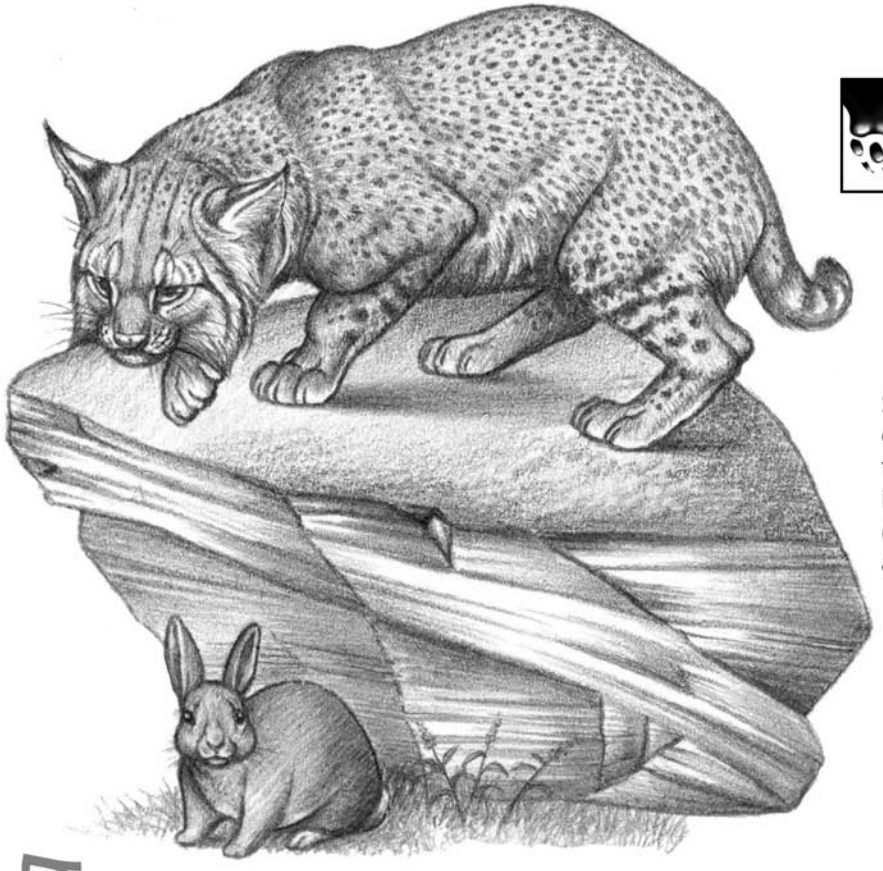
No other animal found at Rancho La Brea has been as captivating as the sabertoothed cat. Our fascination with this species has led it to become the official state fossil of California. In reality, even without its prominent saber teeth, this cat would have been a deadly predator. The sabertoothed cat had strong limbs and a heavy muscular build, making it much more bulky than other cats, which tend to be agile and nimble. The sabertoothed cat had a short tail (similar to a bobcat) and research suggests that it relied on its powerful muscles to ambush and pounce upon prey, instead of chasing it in a manner similar to lions and other cats. Many fossils of this cat show healed injuries and diseases that would have crippled the animal. This evidence suggests that the cats might have been social animals, living in groups or prides, and caring for the old and sick members.



Foot Note!

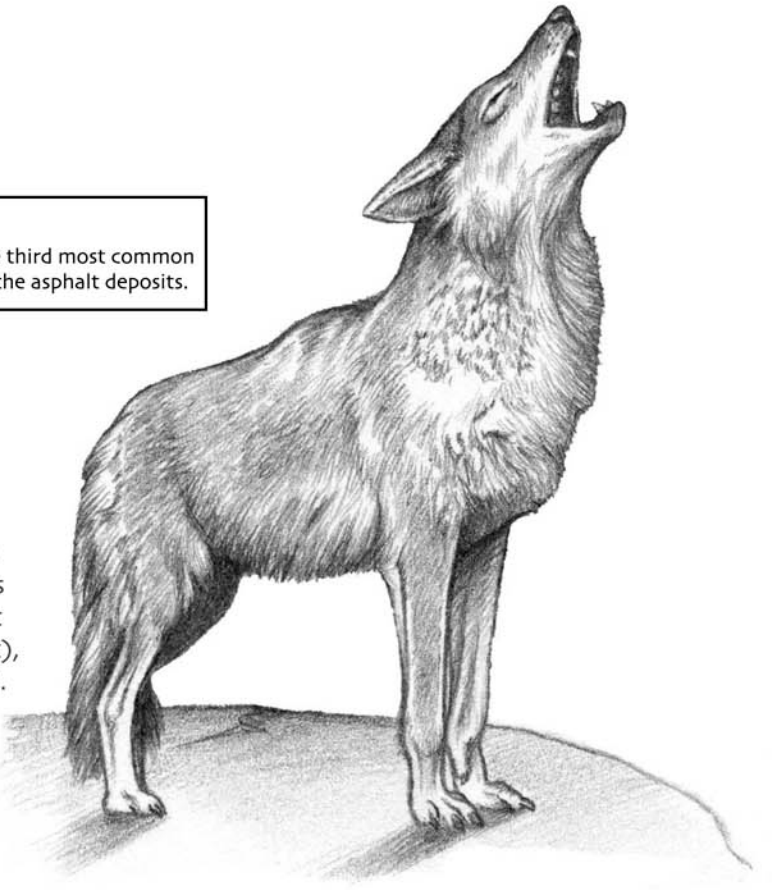
NOT A TIGER! The sabertoothed cat, mistakenly called a "sabertoothed tiger," is actually scientifically classified in a separate group from true cats. The sabertoothed cat's lack of a long tail and other physical characteristics place it closer to a bobcat than a lion or tiger (i.e. you wouldn't call a large bobcat a "bob-tiger").

Other Carnivores



Foot Note!

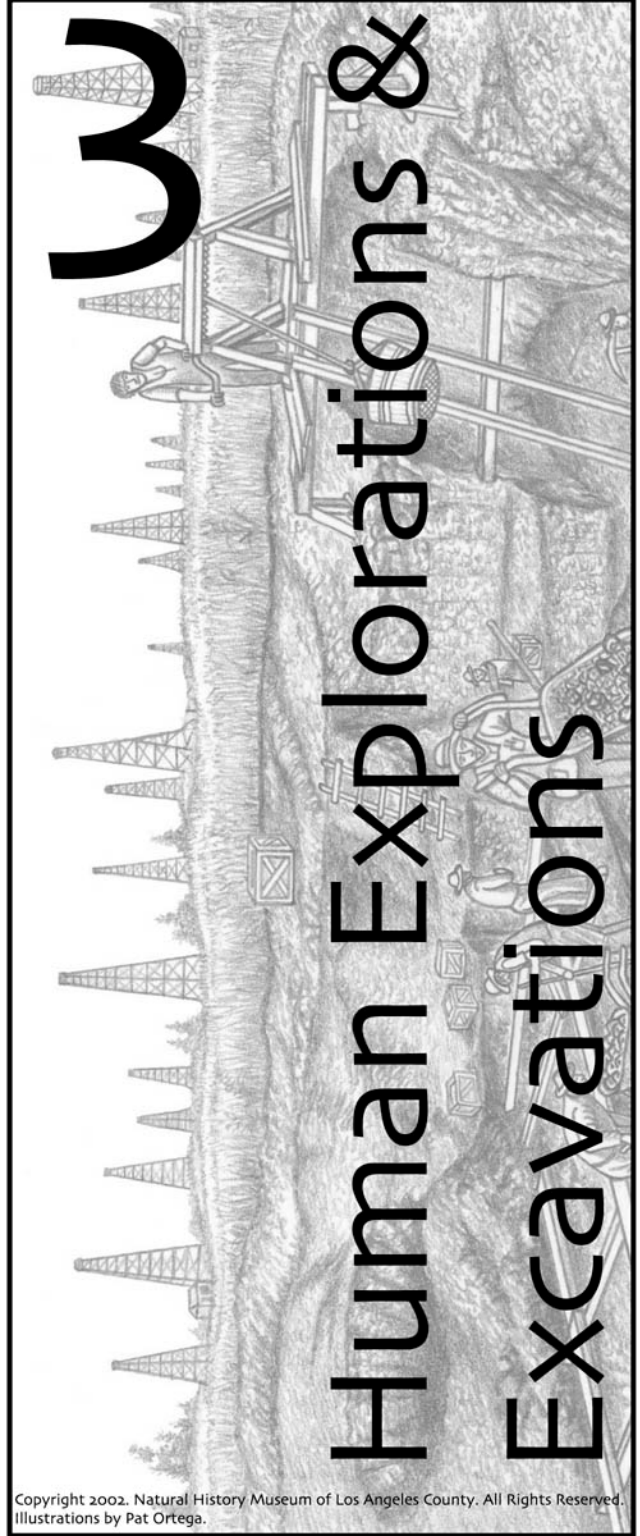
The coyote is the third most common animal found in the asphalt deposits.



Some of the main carnivores found in the asphalt deposits included the bobcat (left), coyote (right), and weasel (below).

Carnivora

Many species of the carnivores recovered from excavation sites at Rancho La Brea are still living. They vary from individuals that are represented by thousands of fossils to species that are only represented by a few bones. Some of the dogs, or canids, include thousands of prehistoric coyotes and small numbers of the living gray fox. In the cat family, the bobcat, puma, and jaguar have been recovered from the asphalt deposits. All these felines have modern relatives. Yet there is one extinct cat, *Homotherium serum*, a different and very rare type of sabertoothed cat, that has been found at Rancho La Brea. Only a few teeth and bones from this cat have been recovered. Other groups of carnivores found in the asphalt deposits include the weasel, skunk and raccoon families; all of which are still living today.



Section 3:
Human Explorations & Excavations

Section Parts:

Ice Age Extinction; Native Americans & Rancheros; Hancock; Scientific Discoveries & Chester Stock; Modern Research & Collections; Pit 91; Charts & Appendix

Ice Age Investigations:

- What kinds of changes were taking place in North America as the Ice Age was ending?

- What were the causes of extinctions in southern California during the last Ice Age? How were the Ice Age extinctions different from what happened to the dinosaurs 65 million years ago?

- How did Native Americans use the asphalt?

- In what ways has the land of Rancho La Brea been used?

- What does the Page Museum laboratory do with fossils?

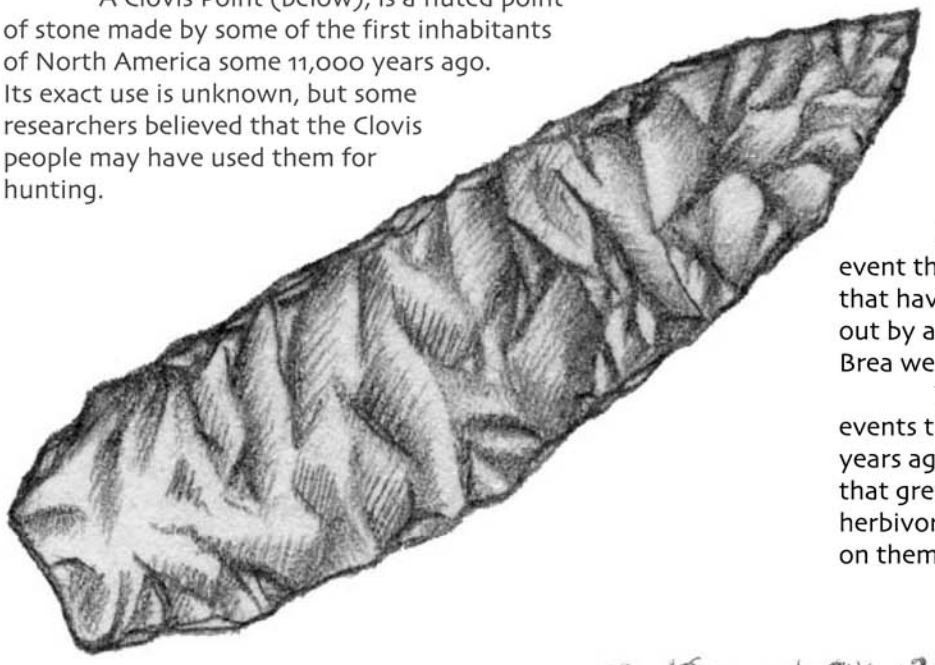
- Are fossils still being found? Why?

La Brea Vocabulary:

- Extinction
- Matrix
- Laboratory
- Paleontology
- Excavation
- Research
- Fossil Preparation

Ice Age Extinction

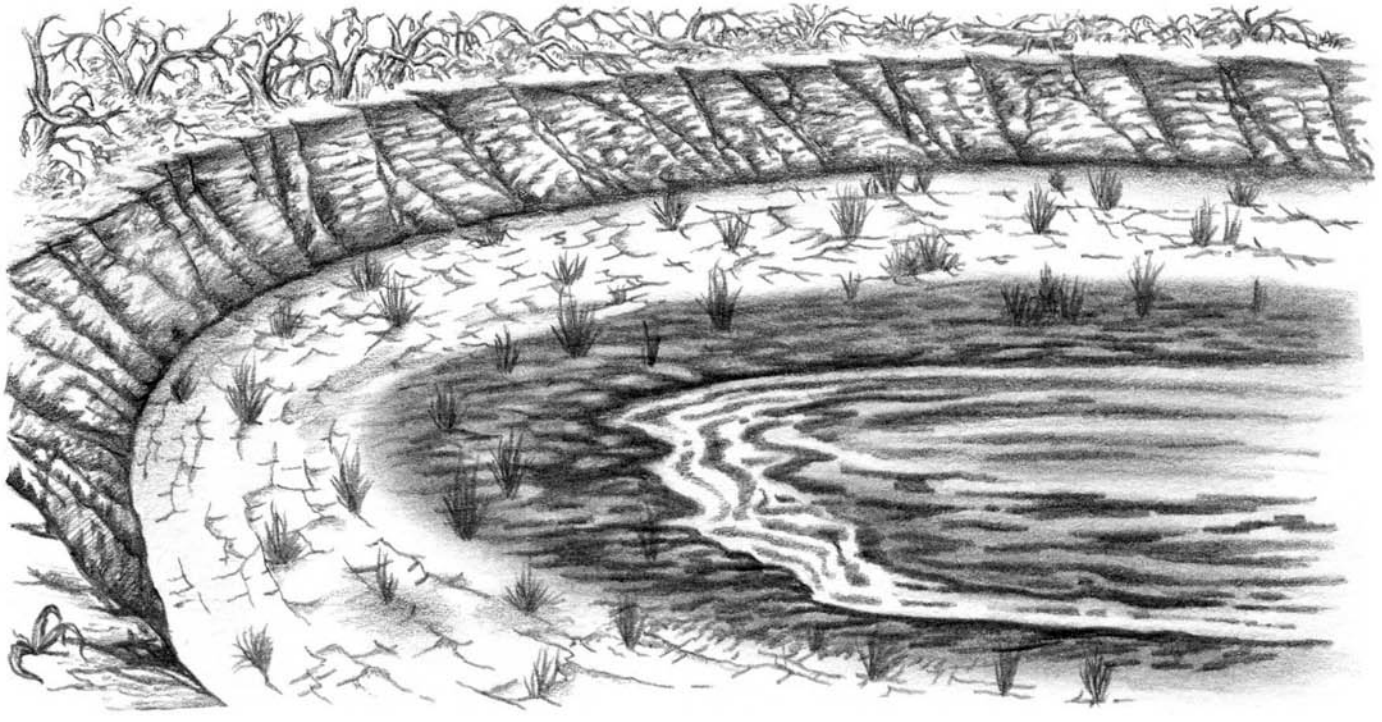
A Clovis Point (below), is a fluted point of stone made by some of the first inhabitants of North America some 11,000 years ago. Its exact use is unknown, but some researchers believed that the Clovis people may have used them for hunting.



One of the mysteries that surround the animals at Rancho La Brea is the extinction event that made many of these animals disappear forever. This extinction event is one of six that have been labeled as "mass extinctions." Yet, unlike the dinosaurs that were wiped out by a large and destructive worldwide event, the causes of the extinctions at Rancho La Brea were much more subtle.

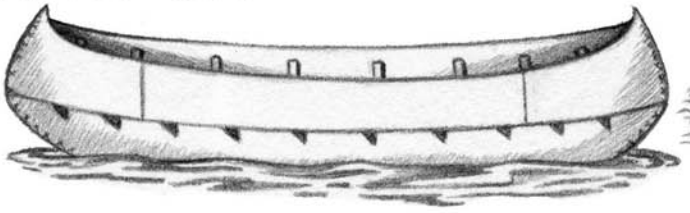
The main theory for this extinction process is a combination of the slow changing events that took place in North America during the short window of time about 12,000 years ago. Climate and weather changes resulted in a drastic shift in the types of plants that grew in prehistoric of Rancho La Brea. The change in plant life had an impact on the herbivores' food supply, which in turn had a direct effect on the carnivores that preyed on them.

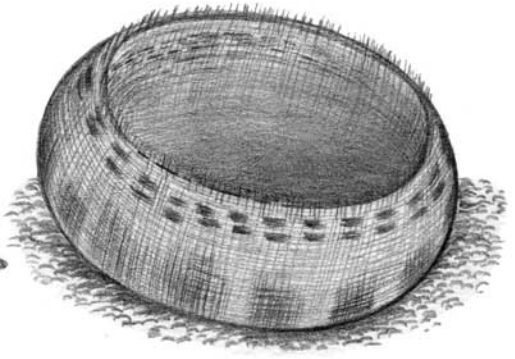
This "domino effect" within the food chain was probably the major cause of the extinctions, but was most likely accelerated by the humans that were beginning to live in North America during the end of the Pleistocene. There is strong evidence to suggest that even if a small human population in North America hunted mammoths and other large herbivores on a limited basis, it would have greatly sped up the extinction process that was already occurring.



During the end of the last great Ice Age, the climate of Rancho La Brea transformed from being humid and cool to the one that exists today. Year-round streams and ponds that once existed, slowly began to dry out (right).

Native Americans & The Rancheros





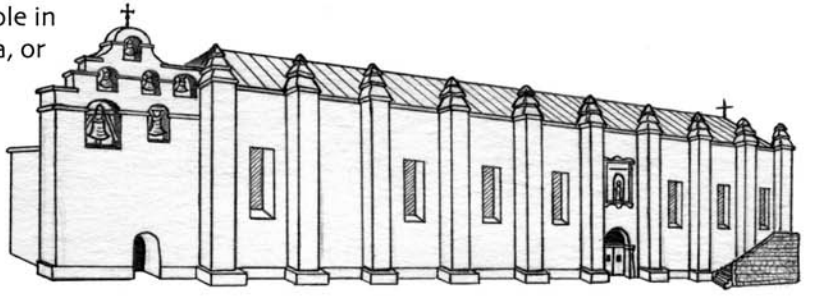
Throughout the last 10,000 years, humans have used the asphalt of Rancho La Brea for a variety of purposes. The Chumash, a Native American tribe from the coastal southern California area, used asphalt for waterproofing their canoes and baskets.

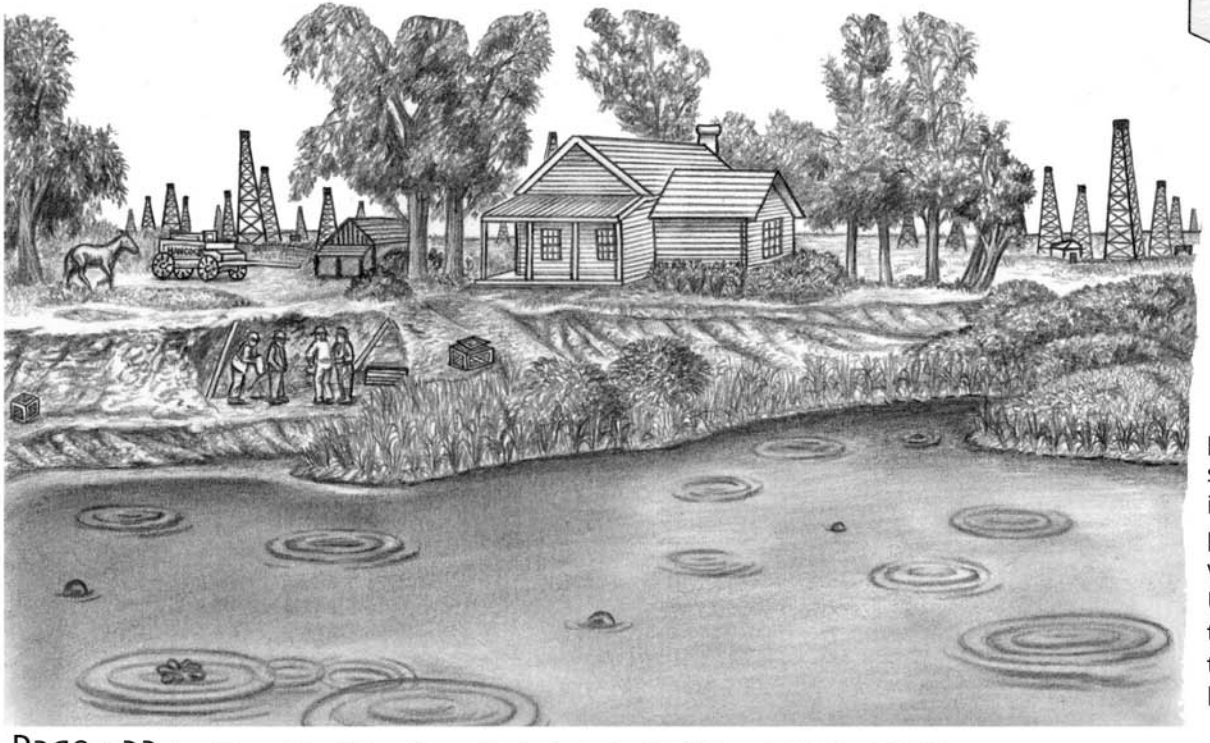
The remains of only one human have been found in the asphalt deposits. Called La Brea Woman, these human remains consist of an incomplete skeleton, and very little is actually known about her or her origins, except her gender and approximate age. She is believed to be about 18-25 years old and was about 4 feet 8 inches tall. The remains are dated to be about 9,000 years old.

In recent history, the Spanish occupation of California about 300 years ago also played a role in the history of Rancho La Brea. It is because of the Spanish that we use the name of Rancho La Brea, or "the tar ranch." Originally, it was a 4,440 acre Mexican land grant used as a cattle ranch. These ranchers first discovered the fossilized remains and dismissed them as the bones of unfortunate cattle that had become stuck in the asphalt.

Foot Note!

The word "brea" means tar in spanish. If one translates "The La Brea Tar Pits" into one language, the translation would be: "The The Tar Tar Pits."





The Chumash canoe and basket (above top), the Spanish mission of San Gabriel (above) and the Hancock ranch house (left) have all played roles in the recent history of Rancho La Brea.

Hancock

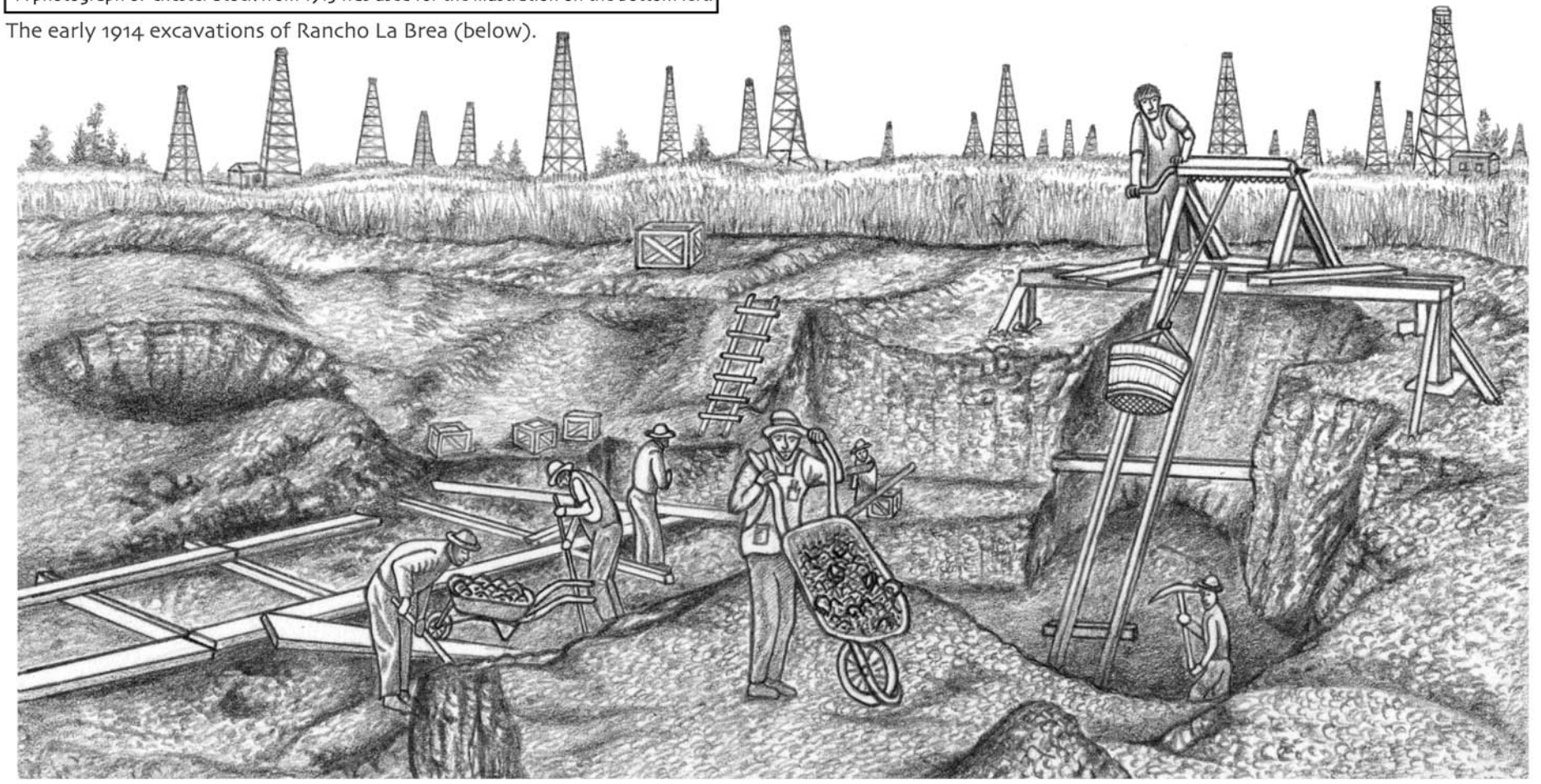
After the American Civil War, the Hancock family purchased Rancho La Brea in the 1870's and discovered the true scientific value of the fossil deposits. While the Hancock family industrially drilled for oil and mined the asphalt to be used for people as far away as San Francisco, a few small scale excavations were made. These excavations were mainly conducted by the University of California, Berkeley between 1901 and 1912. In 1913, the Museum of History, Science, and Art—which later became the Natural History Museum of Los Angeles County—launched large scale excavations which lasted almost two years.

Scientific Discoveries & Chester Stock

Foot Note!

The artist Pat Ortega used many of the original photographs taken during the 1913-1915 excavations to draw the composite illustration that you see below. A photograph of Chester Stock from 1915 was used for the illustration on the bottom left.

The early 1914 excavations of Rancho La Brea (below).



Chester Stock at his desk while at the University of California-Berkeley (below). Next to him is the skeleton of a tree sloth.

During the large-scale excavations of 1913 to 1915, a million fossilized bones were unearthed and cleaned from 96 quarries or "pits." After this massive process, much of the scientific research on the newly discovered animals was done by Chester Stock. A graduate of the University of California, Berkeley and a professor at the California Institute of Technology (Caltech), Stock eventually became one of the most famous paleontologists in modern history for his research, discoveries, and publications on the fossils of Rancho La Brea.

Foot Note!

During the 1913-1915 excavations, workers earned the reasonable salary of $3.50 a day, but by modern standards, the working conditions were quite dangerous. Shoring (boards inserted to prevent collapse of the quarry walls) was quite primitive, cave-ins were common, and the warm kerosene used to clean the bones was highly flammable.

Modern Research & Collections

The hundreds of thousands of people who visit each year get to see the actual scientific discoveries take place. Through the windows at the world famous "fish bowl" laboratory inside the museum, people of all ages can see the scientists clean, examine, restore, and catalogue the fossils that are still being found in the asphalt.

By using tools such as dental picks, toothbrushes, cotton swabs, and solvents to help soften and dissolve the asphalt, scientists clean and identify the fossils recovered. After the fossils are cataloged, they are moved into storage so that they can be easily found for later examination and study. Through this process, scientists piece together the questions and puzzles that still remain about the last great Ice Age.

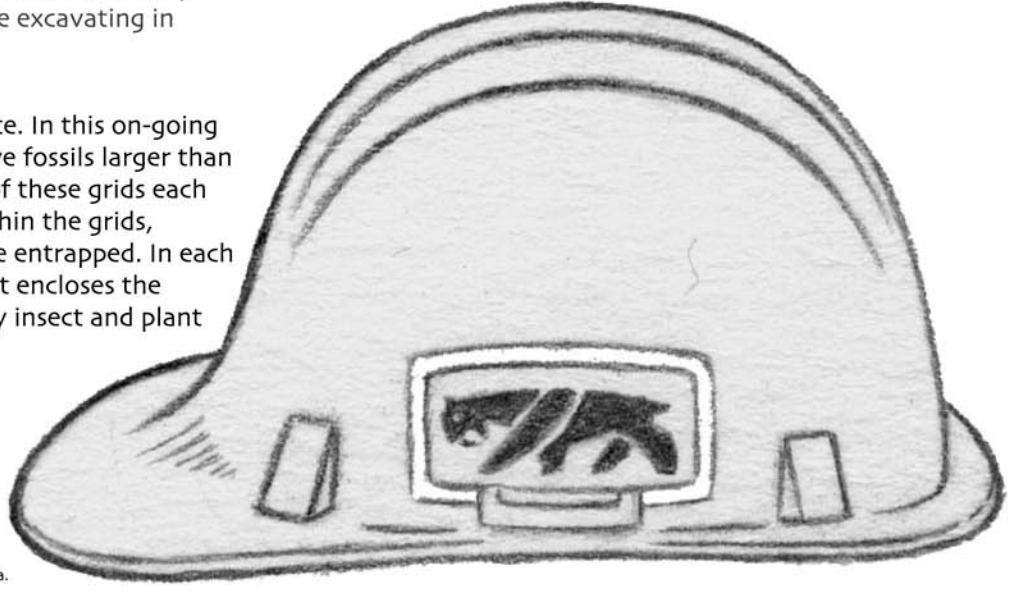
Foot Note!

The millions of cataloged bones found at Rancho La Brea take up such a large area that almost the entire perimeter of the George C. Page Museum (except for a few offices) is used as the storage area for the mammal, bird, and plant remains.

Paleontologists at the Page Museum use simple and delicate tools (above) in the laboratory, and hard hats (below) while excavating in Pit 91.

Pit 91

Just outside the Page Museum in Hancock Park is the Pit 91 excavation site. In this on-going excavation, modern techniques and practices are used to carefully find and remove fossils larger than half an inch, in three foot square and six inch deep grids, at a pace of about four of these grids each season. By carefully mapping and photographing the fossils as they are found within the grids, scientists understand how the pits formed and how the animals may have become entrapped. In each two month-long excavation season, about 1000 bones are recovered. The dirt that encloses the bones is then treated with solvent to remove the asphalt so that microfossils (tiny insect and plant remains, and shell and bones) can also be recovered.



Foot Note!

Started in 1969, the Pit 91 excavation is the longest on-going urban paleontological excavation site in the world! The excavations are conducted during the summer months from early July till the beginning of September each year.

Suggested Readings:

Harris, John M., and George T. Jefferson. 1985. *Rancho La Brea: Treasures of the Tar Pits.* Los Angeles: The Natural History Museum of Los Angeles County, 87 pp.

Harris, John M. 2001. Rancho La Brea: Death Trap and Treasure Trove. *Terra (Special Edition): Volume 38, Number 2.* Los Angeles: The Natural History Museum of Los Angeles County, 56 pp.

Stock, Chester and John M. Harris. 1992. *Rancho La Brea: A Record of Pleistocene Life In California.* Los Angeles: The Natural History Museum of Los Angeles County, 113 pp.

Charts of Relative Proportions of Fossils:

Foot Note!
For a complete list of all the types of plant and animal fossils found at Rancho La Brea, please visit the following page on the Internet: http://www.tarpits.org/fossils/list.html

Mammals: Carnivora (90%) - Artiodactyla (5%) - Perissodactyla (2.5%) - Edentata (2%) - Proboscidea (0.5%)

Carnivora: Cat, Bear, Wolf, Coyote, Weasel
Artiodactyla: Camel, Pronghorn, Peccary, Bison
Perissodactyla: Horse & Tapir
Edentata: Ground Sloth
Proboscidea: Mammoth & Mastodon

Birds: Falconiformes (60%) - Galliformes (15%) - Strigiformes (7%) - Passeriformes (8.5%) - Anseriformes (4%) - Charadriiformes (2%) Others (3.5%)

Falconiformes: Eagle, Hawk, Condor, Teratorn
Galliformes: Turkey & Quail
Strigiformes: Owl
Passeriformes: Raven, Lark, Magpie
Anseriformes: Duck & Goose
Charadriiformes: Killdeer, Curlew, Avocet
Others: Stork, Crane, Dove, Pigeon, Roadrunner

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RETURN TO THE ICE AGE:
The La Brea Exploration Guide

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