La Brea Tar Pits: An Introductory History (1769–1969)

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Abstract

In the first two decades of the twentieth century, hundreds of thousands of fossils were excavated from the Rancho La Brea Tar Pits. Prior to that time, these pits were unknown. When Spanish settlers first arrived in the area of Los Angeles in the eighteenth century, they found a number of tar springs located in the middle of a large plain at the foot of the Santa Monica Mountains. Surrounding the springs was a scattering of animal bones visibly embedded within a layer of asphalt. It was not until the mid 1870's that people began to realize the remote antiquity of these bones. Soon after exploratory excavations began in the early 1900s, scientists were finding tar pits containing large numbers of fossils.

The conventional explanation for the occurrence of these fossils is that thirsty birds and mammals, deceived by water-filled pools of tar, had blundered into these viscous traps and died in them. Although widely accepted, the entrapment theory has failed to give convincing answers to some key evidentiary questions, including the physical characteristics of tar pits, the fragmentation and chaotic intermingling of the bones, and the numerical preponderance of the carnivores. Since these issues cannot be adequately resolved by the entrapment theory, then a new explanation is needed. The evidence seems to be pointing toward the possibility of a single catastrophic flood as the agent for fossil deposition at the La Brea Tar Pits.

Introduction

The Rancho La Brea Tar Pits in Los Angeles, California are widely regarded as one of the richest sources of mammal fossils in the world. Approximately 60 species have been identified, including saber-tooth cat, bear, lion, wolf, camel, bison, and mastodon. Also found were seventeen human bones, including a pelvis and a skull, as well as a number of artifacts such as milling stones and bone hairpins. The conventional explanation for the abundance and diversity of this fossil material is that successive animal entrapment episodes had created an ever-growing mass of bones at the bottom of tar pools. An unwary horse, for example, might step into a seemingly benign pool of water to get a drink. Becoming ensnared in the tar underneath the watery surface, its distress cries would draw hungry carnivores, such as wolves, seeking an easy meal. These carnivores would themselves slip and fall into the pool, becoming, like their prey, inescapably trapped. Although this theory is useful for interpreting some of the data, it does have serious weaknesses. This article points out the inadequacies of the entrapment theory and shows why an alternative explanation is needed.

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Tar Springs and Tar Pits

When Spanish settlers first moved into the area of Los Angeles during the eighteenth century, they saw an alluvial, grass-covered plain about 45 miles in circumference at the foot of the Santa Monica Mountains. In the middle of this plain was an area of about 20 acres where tar flowed out of numerous vents and made black puddles amidst the sandy dirt and tufts of grass. Thick and viscous, the emerging tar formed volcano-shaped mounds that generally measured several inches above the surrounding level of the ground. The tar was a useful substance to Indians in the region, who used it to caulk their canoes, waterproof their baskets, and attach wooden handles to stone blades.

The first record of these tar springs was made in 1769 during a Spanish survey expedition led by Gaspar de Portola. On August 1, the expedition reached an Indian village called Yang-na, the site of the future town of Los Angeles. Two days later, one of the Franciscan friars accompanying the expedition, Father Juan Crespi, noted in his diary that they saw "extensive swamps of bitumen" in an area about seven miles west of the village (Stock and Harris, 1992, p. 2). A more lengthy description was given by a traveler named Jose Longinos Martinez in 1792 (quoted in Stock and Harris, 1992, p. 2).

> Near the Pueblo de Los Angeles there are more than twenty springs of liquid petroleum, pitch, etc.

> Farther to the west of said town . . . there is a great lake of pitch, with many pools in which bubbles or blisters are constantly forming and exploding. They are shaped like conical bells and, when they burst at their apex, they make a little report. I examined the holes left by the bubbles, but when they explode they are followed by others in succession and gave one no opportunity to examine the cavity.

In 1828, an ex-Portuguese sailor named Antonio de Rocha became the owner of the tar springs through a land grant of one square league, or 4,439 acres, given to him by the Mexican government. Since the Spanish word for tar is "brea," the Rocha estate became known as Rancho La Brea. One of the conditions of the grant was that Rocha allow local inhabitants to come to the ranch and obtain as much tar as they needed. Generally, the tar was used to waterproof the roofs of adobe houses.

The first geologist to examine these springs was William P. Blake, who visited the area in 1853. The following is a description of a tar spring he saw (quoted in Merriam, 1912).

> This spring was nothing more than an overflow of the bitumen from a small aperture in the ground around which it had spread on all sides, so that it covered a circular space about 30 feet in diameter. The accumulated bitumen had hardened by exposure and its outer portions were mingled with sand, so that it was not easy to determine its precise limits. It formed a smooth hard surface like a pavement, but toward the center it was quite soft and semifluid, like melted pitch.

The "accumulated bitumen" mentioned by Blake is an extensive field of asphalt, about one to two feet in depth, mostly covered by alluvial topsoil. Extending beyond the observable outpourings of the springs, it has been estimated that this field of solidified petroleum is somewhere between 160 to 600 acres. Although this layer is as hard as road pavement, it nevertheless develops fractures, which allow upsurging flows of oil to escape to the surface. In 1865 another geologist named J. D. Whitney visited the springs and wrote a description of what he saw (quoted in Merriam, 1912).

> Over a space of 15 or 20 acres the bituminous material, which, when seen by us, in the winter, had exactly the consistency and color of tar was oozing out of the ground at numerous points. It hardens on exposure to the air and becomes mixed with sand and dust blown into it, and is then known as "brea." The holes through which the bitumen comes to the surface are not large, few being more than 3 or 4 inches in diameter. On removing the tarry substance from the holes, by repeatedly inserting a stick, the empty cavity was very slowly filled up again. . . . A very large amount of the hardened asphaltum, mixed with sand and the bones of cattle and birds have become entangled in it, lies scattered over the plain.

Whitney's belief that the bones were the remains of recently trapped animals had some validity, for the carcasses of birds, rabbits, squirrels, and other small animals have sometimes been found lying partially submerged in the tar. From time to time, these sticky puddles would immobilize wandering cows and horses. If no one came to rescue them, they would die from thirst or hunger.

The first scientist to realize that there were bones of remote antiquity in this area was a geologist from Massachusetts named William Denton (Merriam, 1912). In 1875 he came to Southern California to inspect oil prospects. At that time, the land comprising the tar springs was owned by Henry Hancock, a Los Angeles surveyor and lawyer, who acquired the property from the Rocha family several years before. Hancock started an asphalt quarry business and employed a work force of 25 Chinese laborers. The asphaltum was processed and sent to San Francisco, where it was used to pave roads. It was also used as a preservative for railroad ties and water pipes. The old quarry can still be seen at the park, now filled in with water and fenced off. Large bubbles of gas burst every minute or so on the oily surface of the pond. In the late 1960's, several life-size fiberglass mammoths were placed around the shore, and a sinking mammoth was tethered to the bottom. Although this dramatic tableau creates the fearsome impression that the pond is a voracious maw of death, it is really just a harmless pool of scummy, malodorous water.

When Denton visited the ranch, he and Hancock talked about fossils. Denton was shown a canine tooth that was found in the quarry. It was nine and a half inches in length and the breadth of the crown was three and a half inches wide. Denton had previously seen a similar tooth from a *Machairodus*, a European saber-tooth cat, but the La Brea canine was substantially larger. He took the tooth and some other animal bones back to Massachusetts and wrote a report of his findings. In spite of the author's enthusiasm, the report failed to generate interest within the scientific community.

It was not until 1901 that anyone took a sustained professional interest in the fossils. While visiting the ranch to check out the prospects for oil production, geologist William W. Orcutt saw a curious mosaic of bones in a section of asphalt that was exposed after the drilling of a water well. Despite the lack of proper tools, Orcutt removed a patch of material from the asphalt and examined it. It was a piece of armored hide from an extinct ground sloth. Excited by this find, he obtained permission from the Hancock family to prospect for more fossils. Finding them was not hard, but extracting these fragile specimens from the rock-like asphalt matrix was a painstaking, laborious process. Often a whole day was spent retrieving a single bone. His patience paid off, and after four years, he possessed an enviable collection of fossils, including the only complete skull of a saber-tooth cat in the world (Orcutt, 1954).

In the latter part of 1905, Dr. John C. Merriam, vertebrate paleontologist of the University of California, Berkeley, learned about Orcutt's collection and began a correspondence with him. After seeing some of the fossils, Merriam agreed that they were significant. Representing the university, he obtained a permit from the Hancock family to conduct a scientific exploration on the ranch.

At this point the historical record becomes a little obscure. Someone, we do not know who, made a momentous discovery. About two hundred yards northwest of the quarry was a pocket of densely packed animal and bird bones, broken twigs, and a few large branches of trees (Stoner, 1913). It was located in an area where, several decades previously (according to field excavation notes), Hancock's laborers had used dynamite to break through the hard bituminous layer to see if there was any commercial grade asphaltum underneath. What made this pocket so desirable, from a fossil extraction point of view, was its soft matrix of tar and sand. It was a relatively easy task to remove the bones, piece by piece, clean them off with kerosene, and analyze them. This discovery, which was later given the name University of California Locality 2050 (Figure 1), brought to light for the first time the paleontological phenomenon that has since been termed "the La Brea Tar Pits."

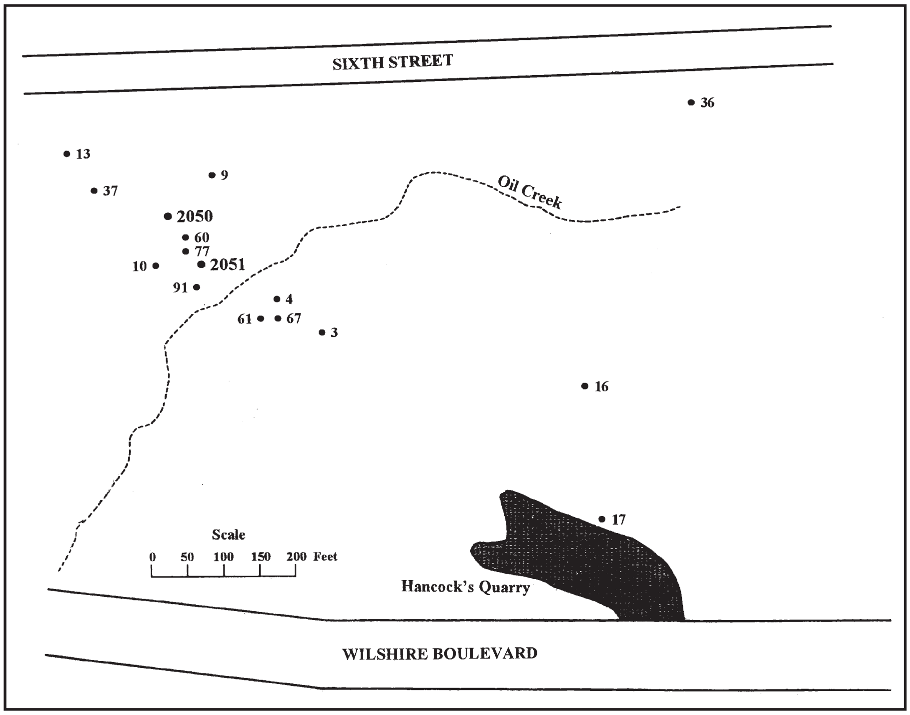

Figure 1. Map of the La Brea Tar Pits. The first discovered fossil-bearing tar pit was the one designated by the University of California as 2050. In 1912 the university began excavating a nearby pit designated as 2051. The other numbered locations were fossil-bearing pits found by the County of Los Angeles during the period of 1913 to 1915. The eight major pits are the ones numbered 3, 4, 13, 16, 60, 61, 67, and 77.

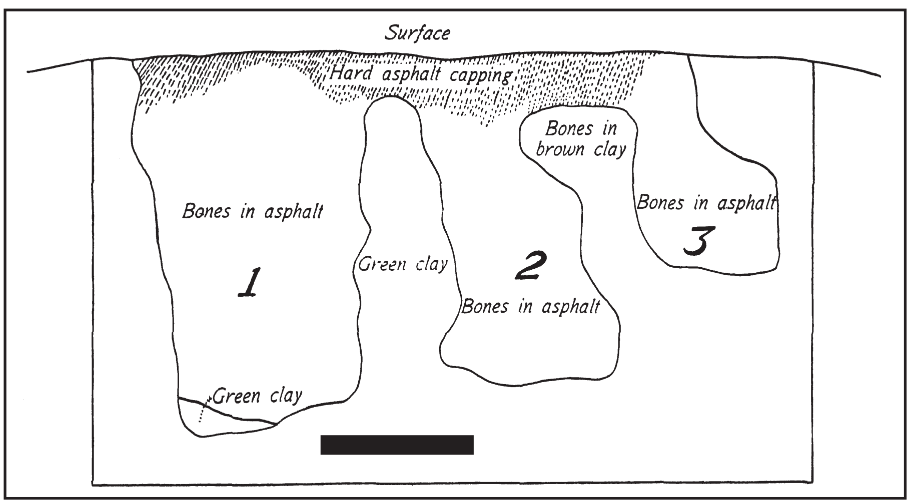

Figure 2. Cross-section of Locality 2051 showing bone pockets. Solid bar = 10 feet. (Stoner, 1913).

The pit at UC Loc. 2050 was shaped roughly like a bottle. The topmost part of the pocket, or the neck of the bottle, was about five feet wide. Below the neck, the pocket extended outward with increasing depth until at ten to twelve feet it was about eight feet wide. The last remaining bones of the pocket were at a depth of 17 feet. The boundary forming the contour of the bottle had a lumpy irregularity as the pressurized tar had pushed its way unevenly into the surrounding green and brown clays.

In 1912, another excavation site, UC Loc. 2051 (Figures 1–4), was started about 70 feet southeast from the first one. This site was notable for having not one, but three, pockets of bone material (Figure 2). The first of these pockets was about 15 feet wide and about 22 feet deep. From this exposure, university excavators moved eastward to find two smaller diameter pockets, one being 21 feet deep and the other 14 feet deep. As in the case of 2050, the bones of 2051 were packed in soft tar and sealed off by the surface layer of asphalt. According to Stoner, "the most interesting observation . . . is that the bones accumulated in

Figure 3. General view of Locality 2051 showing pocket 3 in the foreground and pocket 2 behind pocket 3 (Stoner, 1913).

Figure 4. Locality 2051 showing mass of bones in pocket 2 (Stoner, 1913).

holes of such small size, and that the deposits were built up to such a thickness." Further on he says,

> . . . the pools were evidently large enough to catch one or two tigers, several wolves and an ungulate at the same time, the latter serving as prey for the carnivores. This association is quite clearly shown in some places, and at one point in particular there were eight wolf skulls and many wolf bones mixed with the bones and skull of a large bison.

As excavators removed the contents of these four pits, they noticed that the tar had preserved the bones to a remarkable degree. Even such delicate features as the courses for nerves and blood vessels were discernable. Also found were various kinds of insects in all their minute detail, including wings and antennae. The pupae of blowflies could still be seen attached to bone marrow cavities. This was a tremendous boon for scientists, who were piecing together the life of animals and insects in the remote past.

The superior grade of preservation that characterized the individual specimens stood in stark contrast to the ravaged appearance of the fossil material as a whole. A majority of the bones were damaged in some way: sharp-edged broken ends, splinters, cracks, impact depressions, deep grooves, broken-off chips, and/or heavy abrasions. Even the bodies of the insects had gone through some inexorable process of dismemberment. If excavators found several insect parts still hanging together, they considered themselves lucky (Pierce, 1946). In addition, the bones were in an entangled mass, closely pressed together, and interlocked in all possible ways. After separating out the bones, scientists could only guess how the parts of individual animals matched up to one another. They also came to realize that the pits were missing a lot of skeletal parts that they had originally expected to find. For example, after six years of digging, less than a dozen parts of the *Megalonyx*, an extinct ground sloth, were collected, including a left humerus, a left calcaneum, a single metapodial of the posterior foot and various elements of both anterior and posterior feet (Stock, 1913).

This chaotic intermingling of damaged and broken fossils seemed to suggest that some monstrous catastrophe had overtaken these creatures of the remote past. Of course, this interpretation was unacceptable to scientists committed to the uniformitarian philosophy. What was needed was a paradigm that could fit these fossils within the realm of mainstream science, even if it had to ignore numerous clues that indicated otherwise. It was under these circumstances that the animal entrapment theory was born. In October 1908, *Sunset* magazine printed an article by Dr. Merriam entitled "Death Trap of the Ages." The subheading read "Sabre-tooth tigers, giant sloths, mammoths, monster wolves, extinct camels, held fast in a huge tar pool near Los Angeles." Included inside the article was a picture of the water-filled quarry. Underneath the picture was a misleading caption identifying the quarry as the "death trap of the ages."

In 1913 Mr. G. Allan Hancock gave the County of Los Angeles the exclusive privilege of doing excavations on his ranch. For the next two years, county excavators dug test holes all around the 23-acre estate in a haphazard search for soft-matrix, fossil-bearing tar pits. Hampering this effort was the surface layer of asphalt. The excavators attacked it with picks, shovels, hammers, wedges, and even dynamite. Since the location of these soft-matrix pits was unknown, they had to make a lot of educated guesses. They dug up the vents of active and inactive tar springs and dug trenches through outcroppings of bituminous material. A tunnel underneath the asphalt had to be abandoned, because the alluvial clay and sand had a tendency to cave in (according to field excavation notes).

Out of a total of 96 test pits, eight had significant amounts of well-preserved bone material, and seven more had inferior material of lesser quantities. Like the bones of

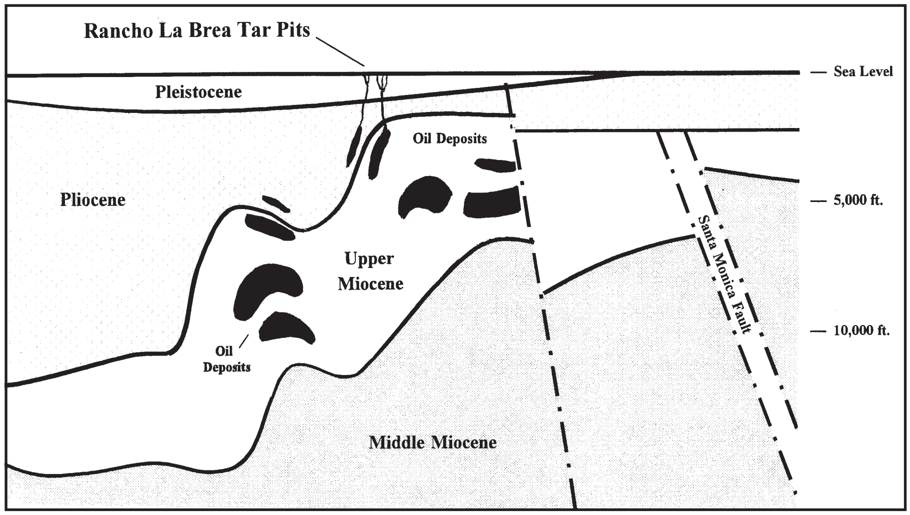

Figure 5. Postulated stratigraphic column of La Brea Tar Pits (Source: Quinn, 1992; credited to Dr. Tom Wright)

the university pits, few of the bones in the county pits had escaped damage. Some had deteriorated because of their proximity to water-saturated stumps and branches. At Pit 4 (Figure 1), one of the eight major pits, an excavator made the following note: "The disposition of this brush and associated material as well as markings on the brush itself, indicate that this stuff was all washed in."

The eight major fossil-bearing pits were of various sizes. On average, they were cone-shaped, about 15 feet in diameter at the top and tapering down 25 feet to a vent several inches wide. The vent coursed downward through about one hundred feet of Pleistocene gravel, sand, and clay (Figure 5). These sediments form the outwash plain between the Santa Monica Mountains and the Pacific Ocean. Below this strata, the tar pit vent continues down through another layer of gravel, sand, and fine-grained marine sediments to oil reservoirs about 2,000 to 6,000 feet below the surface of the earth. This oil-bearing second layer is called Upper Miocene, and it forms the basin of the Los Angeles region (Quinn, 1992; Stock and Harris, 1992, p. 10). According to Wyman (1926, p. 9), the pits were originally created by blowouts of natural gas. Heavy subterranean fracturing by earth tremors allowed pressurized gas to escape upward and penetrate the surface alluvial layer at numerous points. Liquid petroleum followed the gas, which filled in these blown out holes.

One of the more unusual pockets was Pit 16 (Figure 1). Only four feet wide with vertical sides, the pit went down 21 feet before it tapered three more feet to the typical three-inch-wide chimney. Somehow numerous animals including dire wolves, saber-tooth cats, coyotes, camels, bison, horses, and even the bulky mastodon had managed to squeeze themselves into a hole not much wider than a bathtub. Although Pit 16 was notable for being one of the eight major pits containing copious amounts of fossils, it is still hard to imagine it as one of the "death traps of the ages."

Besides the constricted size of the pits, an additional difficulty for the entrapment theory is the transitory character of the tar itself. According to radiocarbon dates done at Pit 9 (Stock and Harris, 1992, p. 9), the bones in the lower part of the pit were 38,000 years old and the bones in the upper part were 13,500 years old. Consequently, the tar in the pit had to remain in a semi-liquefied state for about 24,000 years. This conclusion contradicts what is known about the process of petroleum encrustation. When crude oil emerges from the ground, it begins to thicken as its more volatile constituents evaporate. Sunlight, heat, and oxidation are all factors in the hardening process (Barth, 1962, pp. 220, 593). Given this observable property of oil congelation, the existence of open pits of tar that could trap animals over a period of thousands of years must be regarded as highly improbable.

Anomalies of the Tar Pits

A mystery that has continued to baffle scientists since the discovery of the tar pits was the numerical preponderance of carnivores. Recent studies of wolf-to-deer populations in Ontario (Canada) and Minnesota (Mech, 1970, pp. 274) and lion-to-herbivore populations in Africa (Guggisberg, 1963, pp. 151–153) show that the ratio is typically 100 to 150 herbivores for every carnivore. What excavators at the La Brea Tar Pits found was an inverse ratio. Using a common skeletal part as a basis (for example, skulls in fairly good condition), distribution surveys consistently showed that carnivores outnumbered herbivores by a ratio of at least seven to one. The lopsided imbalance can be seen in the bar graph of the ten most common mammals (Figure 6). The right four bars show that carnivores represent 85% of the total number of individual animals. The oddity of seeing so many meat-eaters among the mammals is reflected in surveys of the avian population, as seen in the bar graph of Figure 7. The flesh-eating birds are about 70% of the total number of individuals. The uncontested leader is the eagle. It is puzzling why eagles would be the most vulnerable to entrapment. Not only are they quite rare when compared to such teeming populations as pigeons and doves, but they are also larger and more muscular and thus more likely to escape.

Perhaps, as some might suggest, a carnivore was more susceptible to entrapment, because it could not resist the sight of ensnared prey flopping helplessly in the tar. Thus a

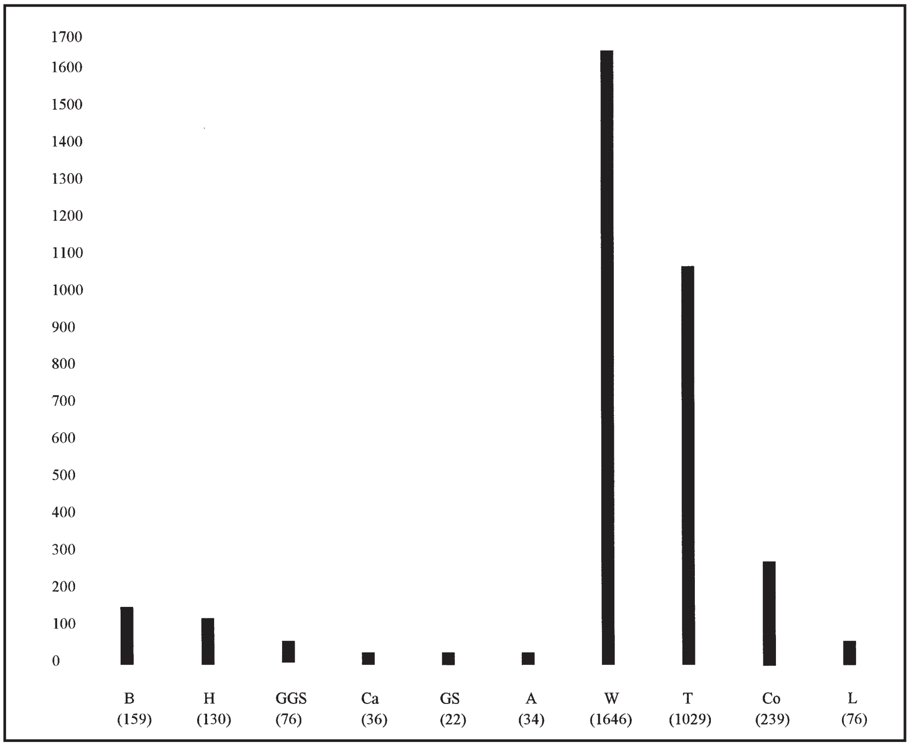

Figure 6. Mammal Distribution Graph. B = Bison, H = Horse, GGS = Giant Ground Sloth, Ca = Camel, GS = Ground Sloth, A = Antelope, W = Wolf, T = Tiger, Co = Coyote, L = Lion. The number in parentheses is the total number of individuals for a given species as found in all pits (Source: Marcus, 1960).

single captive bird or animal could lure many predators to their deaths. This line of reasoning loses its force when one compares the La Brea statistics with those of a modern tar pit. In 1934 A. E. Borell, a wildlife specialist employed by the Grand Canyon National Park Service in Arizona, noted that birds were getting caught in a tar pit that had been left by a road construction crew several years before. Borell found carcasses in all stages of decomposition from skeletons to those that had recently died. An examination of the contents of the pit revealed that there were 123 individual birds of 13 different species. Six of these birds were hawks. Borell made a repeat visit thirty days later and found that eight more birds had died in the tar pit, none of which were hawks. Thus the ratio of 131 to 6, or about 22 to 1, reflects the expected balance in nature (Borell, 1936). This evidence shows that there are no specific phenomena that would augment a tar pit's allurement to any particular kind of creature.

Another statistical anomaly is the predominance of land birds over water birds. The total percentage of water birds is only 8%. This low percentage has puzzled scientists, since wading birds such as ducks, geese, and coots have a profile of characteristics that make them the most likely candidates for entrapment (Miller, 1910; Howard, 1955, pp. 38–39). Yet, as it turned out, the largest category of victims among the non-predacious types was the turkey, a land-roving bird.

One more anomaly that should be mentioned is the absence of soft tissues from both mammals and birds. Neither skin, hair, feathers, scales, claws, beaks, talons, or any internal organs have ever been found in any of the tar pits. This absence is remarkable since, as previously mentioned, the parts of insects had been preserved.

The La Brea Tar Pits from 1915 to 1969

As the fossils were being taken out of the pits, county excavators packed them in crates and carted them over to the Museum of History, Science and Art, which later became the Natural History Museum of Los Angeles. The last of the excavations ended in December 1915. For many years afterward, this huge collection of over 700,000 specimens kept scientists busy making inventories and churning out monographs on new species of birds and mammals. This descriptive phase was largely completed by the late 1950s. In spite of the great quantity of papers written, only a few addressed the mechanism of the entrapment theory in a meaningful way. It has only been in recent years that attempts have been made to refine the entrapment theory to make it more conformable to the reality of the evidence.

In 1969, Pit 91 (Figure 1) was re-opened for renewed excavations. This task of collecting more data has been continuing every summer to the present time. It is more thorough in its recovery of fossils than the old excavations of 1905–1915. Special attention is being paid to smaller life forms such as diatoms, pollen, seeds, snails, mollusks, and ostracods. Every cubic centimeter is carefully sifted and examined for the slightest particles of fossil content. As each piece is removed, its position and orientation is recorded in field excavation notes.

In a future article, I will summarize the results of excavation work done since 1969. I will also discuss the modified direction that scientists are taking in their thinking about the tar pits. Yet in spite of the theoretical adjustments and the vast quantities of data being collected, the problems facing uniformitarians are no closer to being resolved than when the entrapment theory was first publicized in 1908. A non-uniformitarian interpretation based on the idea of a major flood may be the only viable way of making sense of the fossils recovered from the La Brea Tar Pits.

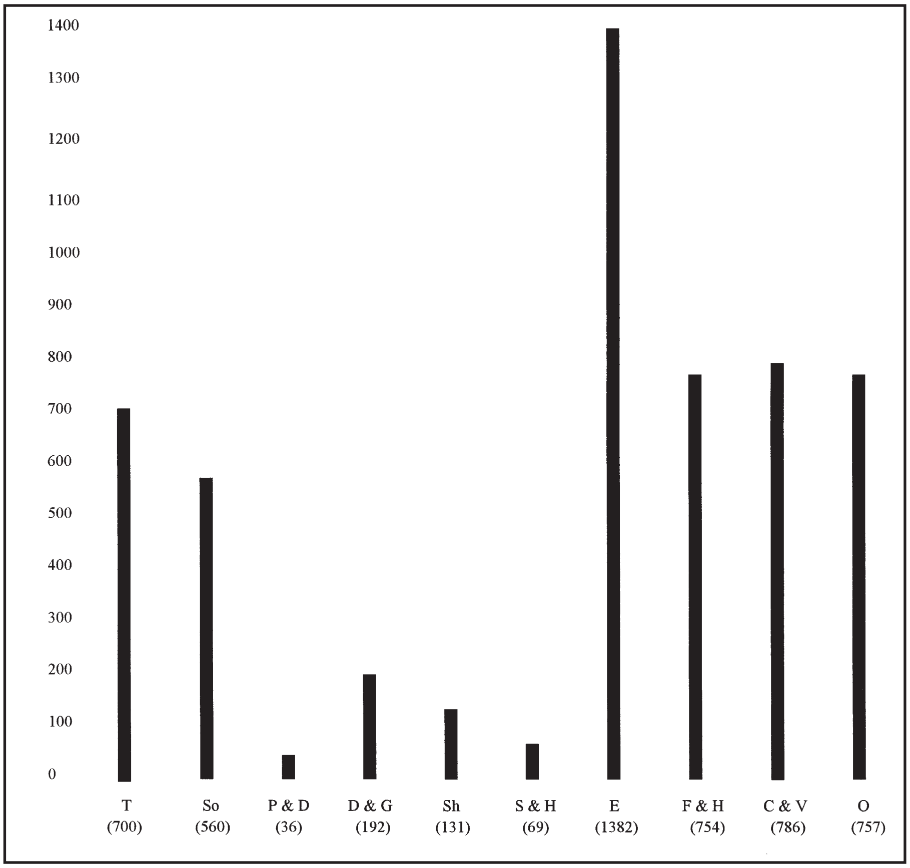

Figure 7. Bird Distribution Graph. T = Turkey; So = Songbirds; P & D = Pigeons and Doves; D & G = Ducks and Geese; Sh = Shorebirds; S & H = Storks and Herons; E = Eagles (960 golden eagles, 170 bald eagles, the remainder are 5 other species); F & H = Falcons and Hawks; C & V = Condors and Vultures (105 teratorns, 225 condors, only a few turkey vultures); O = Owls. The number in parentheses is the total number of individuals for a given species as found in thirteen pits (Source: Howard, 1962).

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It is considered likely that all the animal hyla became distinct before or during the Cambrian, for they all appear fully formed without intermediates connecting one phylum to another.

Douglas Futuyma, *Evolutionary Biology*, second edition, 1986, p. 325