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Article Summary: In the 1930s and 1940s paleontologists collected quantities of large animal fossils from Miocene Age river deposits laid down 19 to 5 million years ago throughout western Nebraska.

Cataloging Information:

Names: Loren Eiseley, Erwin H Barbour, Morris F Skinner

Geologic Time: Miocene Epoch, Hemingfordian Age, Barstovian Age, Clarendonian Age, Hemphillian Age

Nebraska Paleontology Sites: Sheep Creek Formation (Sioux County), Valentine Formation, Norden Bridge Quarry (Brown County), Ashfall Fossil Beds (Antelope County), Pratt Slide (Brown County), Shoreline site (Lake McConaughy), Cambridge Quarry (Furnas County), Devil's Gulch (Brown County), Lower Snake Creek (Sioux County)

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Photographs / Images: image of giant salamander chasing its lunch in a Western Nebraska river 15 million years ago; complete skull of horned rodent found in Cherry County; teeth of browsing horses and grazing horses from the Valentine Formation; skull of wolf-like dog from near Long Pine; jaws of a lion-like sabertooth cat from Lake McConaughy; image of a four-tusker, the most common fossil elephant in the Valentine Formation; skull of an extinct prongbuck from Hitchcock County; Rick Otto and Michael Voorhies in the Rhino Barn at Ashfall Fossil Beds State Historical Park; front feet of five different Miocene horses from the Ashfall site with the same bones of a modern horse for contrast; skull of an *Epicyon* ("top dog") found along the shore of Lake McConaughy with the smaller skull of a 130-pound St. Bernard; lower jaw of the first shovel-tusked elephant fossil, found near Cambridge in 1926; image of the last Nebraska alligator and a scoop-tusked elephant based on fossils from a 9-million-year-old lake deposit in Cherry County; image of a shovel-tusked elephant as it may have looked in life; field party with elephant bones at Devil's Gulch, March 9, 1916

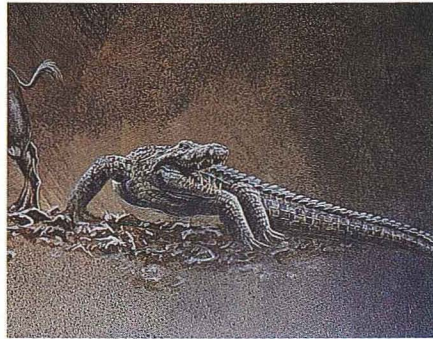


Remains of more than 40 species of extinct rhinoceroses have been discovered in Nebraska rocks. This massive skull is from one of the last and largest American rhinos, a hornless browser called *Aphelops* that was as big as the largest living rhinos. It was collected from a 7-million-year-old gravel deposit near Cambridge along with the remains of shovel-tusked elephants and the giant sabertooth *Barbourofelis*.

CHAPTER FOUR

Camels, Rhinos and Four-tuskers

Miocene Grasslands and Jungle Rivers



Miocene-age alligator

By Michael R. Voorhies
University of Nebraska State Museum

IN LAYERS OF SEDIMENT DEPOSITED on the eroded surface of older Arikaree rocks in the Nebraska Panhandle are clues to the evolution of animals that inhabited the area during the rest of the Miocene from 19 million to 5 million years ago. After the long dry spell of the Arikareean, stream deposits, for the first time containing granite pebbles from the Rockies, yielded a considerable diversity of aquatic fossils.

Alligators and pond turtles are fairly common, and we find our oldest examples of the alligator snapping turtle which lives only in the southeastern United States today. Fish from those beds include large flathead catfish as well as channel cats and bullheads, along with the usual gar and bowfin. Perhaps the most startling creatures in the black lagoons, however, were wide-mouthed salamanders up to five feet long closely related to the somewhat smaller giant salamanders that survive in southeast Asia today.

Miocene

Enormous collections were made in the 1930s and 1940s from Miocene age river deposits scattered throughout western Nebraska. Loren Eiseley labored at a site near Bridgeport in 1932, and many years later, in *The Unexpected Universe*, reminisced about the sheer boredom sometimes involved in amassing the raw data of paleontology:

“There was an eroding hill in the vicinity, and on top of that hill, just below the sod cover, were the foot bones, hundreds of them, of some lost Tertiary species of American rhinoceros. It is useless to ask why we found only foot bones or why we gathered the mineralized things in such fantastic quantities ...

but ... orders had come down, so we dug carpals and metacarpals till we cursed like an army platoon that headquarters has forgotten.”

Hemingfordian: 19 Million Years Ago

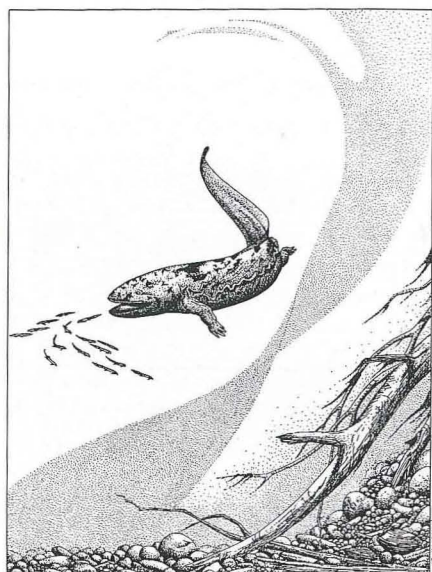
Fossil beds excavated in Box Butte County contain such an exceptional record of early Miocene life that the county seat, Hemingford, has joined the ranks of Nebraska towns for which a North American land-mammal age is named. Hemingfordian fossils are known from California to Saskatchewan to Florida, but by far the most productive deposits are in Nebraska and adjacent parts of South Dakota, Wyoming and Colorado.

When skulls of rhinos showed up at the Bridgeport quarry where Eiseley was working they turned out to have a knobby pair of horn bases on the nasal bone just as Agate rhinos do. But they were larger and therefore classified as a more advanced species of *Menoceras*. Bridgeport horses, oreodonts and carnivores are also significantly different from their Arikareean ancestors.

Just as the Bridgeport quarry collections are dominated by rhino bones, camel remains are overwhelmingly abundant in the Hemingford quarries. Two kinds are common, one a bit smaller (*Michenia*) and one a bit larger (*Protolabis*) than a modern llama but otherwise similar in overall build. Their teeth are more numerous and shorter crowned than those of llamas, indicating that their diet was less abrasive. We find our first abundant record of fossilized grass seeds and stems in Hemingfordian deposits, but tree remains also are common, suggesting that plenty of browse was still available. One rare Hemingford species, nicknamed the “giraffe camel” had an exceedingly long neck and was probably a treetop browser.

The first large mammals to become specialized grazers, taking full advantage of the newly developed grasslands, seem to have been horses. Although many Hemingfordian species — browsers — changed little over time, several kinds of horses — grazers — evolved taller-crowned teeth better able to deal with abrasive grasses. By late Hemingford time, one species called *Merychippus primus* had developed blocky, cement-covered molars with crowns taller than they are wide and chisel-like incisors shaped for clipping grass.

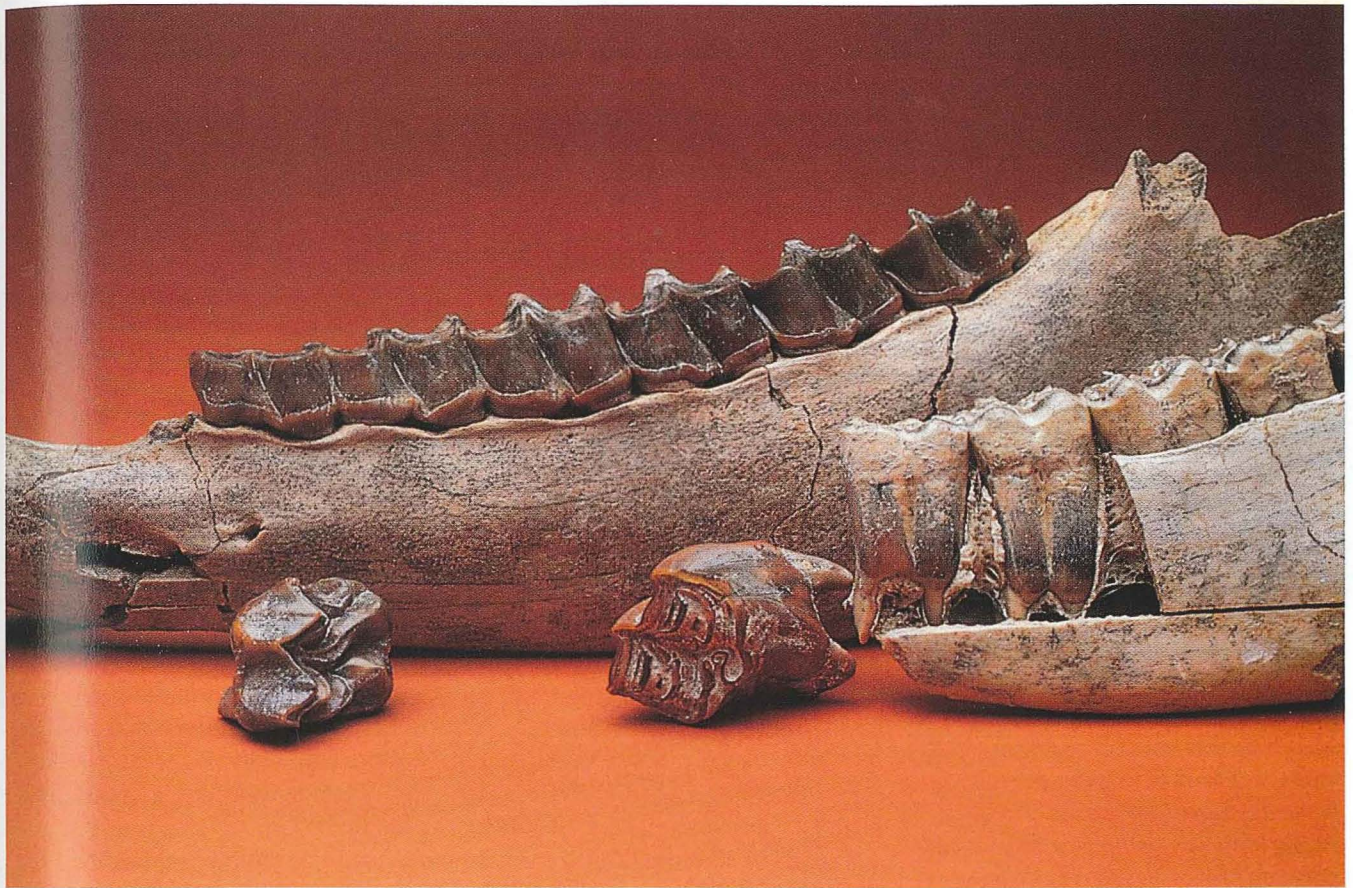
Many rodents adapted to the spread of grassland by going underground. Flat, wide skulls and huge claws on the front feet identify one group of large rodents, the mylagaulids, as burrowers, but their most distinctive feature is the presence (in males) of horns on the nose. Other small mammals that turn up frequently in Hemingfordian deposits are hedgehogs (newly arrived from



Giant salamander, *Andrias matthewi*, chasing its lunch in a western Nebraska river 15 million years ago. Smaller relatives of this wide-mouthed predator called hellbenders live in fast-moving streams in the eastern United States today.

The world's only horned rodent lived in Nebraska throughout the Miocene Epoch from 24 million to 5 million years ago. This complete skull is from the middle Miocene Valentine Formation in Cherry County. Small eye sockets suggest these animals had tiny eyes and spent their lives underground using their large claws for burrowing.





Asia), shrews, moles and *Plesiosorex*, a giant insect-eater with powerful jaws and wicked-looking teeth that has no close living relatives.

Species of the dog family, mostly in the fox- to coyote-size range, are the most common predators, but several beardedogs also have been found, including some as big as modern bears. A puzzling feature of early Hemingfordian faunas is the total absence of true cats or cat-like nimravids. America's first true cats, with the confusing scientific name *Pseudaelurus* ("false cat"), appear in late Hemingfordian deposits between 16 million and 17 million years old called the Sheep Creek Formation.

Mammals that probably spent considerable time in the water include our oldest otters and swarms of tiny beavers about the size and shape of young modern muskrats (their dryland, burrowing cousins had become extinct by that time). Larger amphibious browsers include tapirs hardly different from modern species that inhabit tropical rivers and use their short trunks to gather leafy plants. Some Hemingfordian oreodonts also had a trunk-like proboscis, judging from their skulls in which the nasal openings had moved back almost as far as the eyes. Another group of probably semiaquatic hoofed mammals were long-snouted creatures called anthracotheres which had the bodies of stretched out pigs. Unlike tapirs, they are extinct, so we can only guess at the function of the bony shields that overhang the eye sockets of their grotesque, flat-roofed skulls.

Overall, a survey of Hemingfordian fossils gives the impression that large herds of rhinos, camels and horses moved through the open woodlands and across fairly extensive patches of grassland in western Nebraska 17 million years ago. Wetter areas close to many rivers supported thick stands of trees and brush that sheltered a diversity of slower moving browsers.

Average body size was still fairly small — a modern horse or cow would

Tooth shape reflects diet. Lower jaw (background) and upper molar (left) are identified as browsers' by their short, enamel-covered tooth crowns. Grazing horse (center and right) has higher crowned teeth, exposed in cutaway lower jaw. Complex enamel folds on chewing surface of upper molars enabled grazers to grind abrasive grasses. These are two of 10 horse species found in the Valentine Formation. They lived 12 million years ago when grasslands were replacing woodlands in the Great Plains.

seem huge in comparison. Giraffe camels were tall but also very slender, probably weighing less than 300 pounds. The largest Hemingfordian mammals, entelodonts weighing up to a ton, died out early in the interval. Several million years were to elapse before truly large animals finally appeared on the North American scene.

Barstovian: 16 Million Years Ago

For the first few million years of the next mammal age, called the Barstovian after fossil beds near Barstow, California, nothing very dramatic happened. Horses became the dominant hoofed animals on the plains both in abundance and diversity with about eight well-defined species. Half were grazers and half were browsers, judging from their teeth. The biggest ones were almost as large as a modern white-tailed deer. Camels also continued to diversify and some increased in size. Giraffe camels, for example, became tall enough to browse 10 or 11 feet off the ground.

Only three species of oreodonts were left, but other kinds of even-toed browsers, the ruminants, expanded in numbers and variety. Largest were the dromomerycids, heavy-bodied, deer-like animals ranging from the size of a goat to a small elk. Both males and females had a pair of erect, unbranched horns on top of the head and a single one rising from the rear of the skull — hence the nickname “three-horned deer” for that extinct family. Much smaller browsers related to living Asian musk deer were especially abundant. Neither sex carried horns, but males had long slashing canines, prompting use of the nickname “sabertooth deer” for *Blastomeryx* and its kin.

Fossils of all those hoofed animals and many more (rhinos, tapirs, chalicotheres, peccaries and “slingshot-horned deer”) have been collected in large quantities from stream deposits in central Sioux County called the Lower Snake Creek beds by old-time paleontologists. Those deposits also produce a great diversity of dogs, beardedogs and mustelids along with scarcer remains of carnivores in the cat, bear and raccoon families. The 15-million-year-old sample of large mammals from the Lower Snake Creek fauna is the largest and most diverse of its age in North America, but little is known about the smaller fry except for beavers and horned rodents.

Two essentially simultaneous events, one geological the other biological, had a profound effect on the fossil record 14 million years ago. A layer of river sand and gravel called the Valentine Formation began to accumulate on the eroded surface of older rocks in north-central and northeastern Nebraska and continued for the next 3 million years. Often 200 feet thick or more, Valentine rocks exposed along the Niobrara River and its tributaries contain abundant fossil plants and small animal remains as well as superbly preserved skeletons of larger mammals similar in most respects to slightly more primitive species found in the older Lower Snake Creek beds. The latter, however, have failed to produce even a scrap of elephant bone or tooth while the Valentine is full of tusk remains.

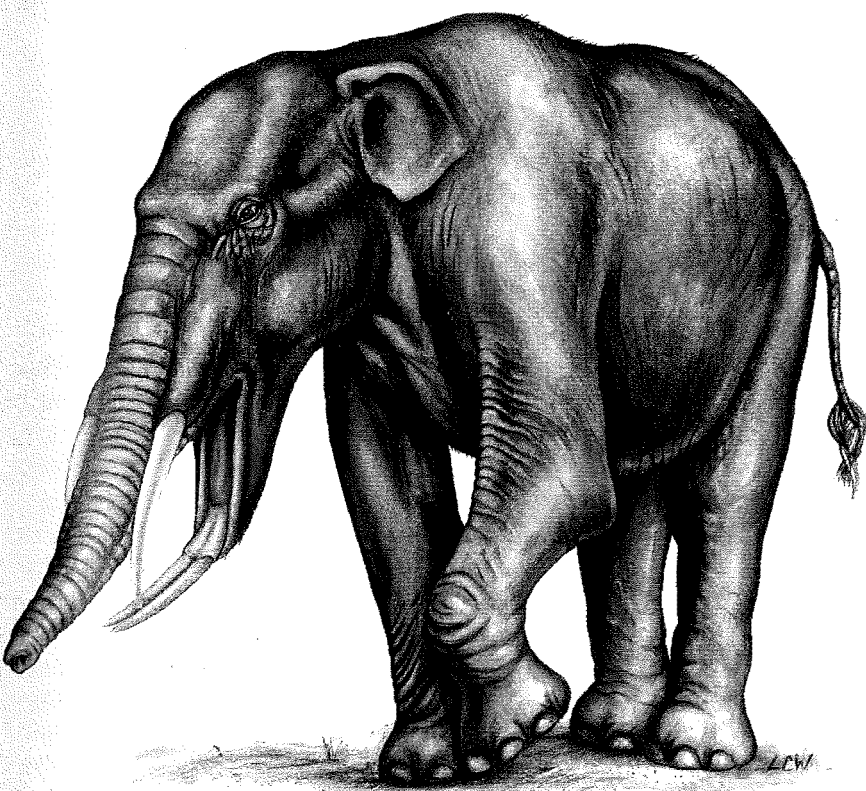
Elephants originated in Africa more than 40 million years ago and eventually spread to Europe and Asia 20 million years later but did not crash across the Bering land bridge to America until 14 million years ago. Two very different kinds of elephants made the crossing: long jawed “four-tuskers” (technically called gomphotheres) and true mastodons, or mammutids, which had shorter lower jaws and sharp-crested molar teeth.

The newcomers encountered little or no competition when they reached the lush savannas of Nebraska. The biggest animal in all of North America at the time was a browsing rhino called *Peraceras crassus* (“very stout hornless rhinoceros”). Big males of that species weighed more than two tons and had



Slicers versus grinders: The jaws of a lion-like sabertooth cat (below) from Lake McConaughy could quickly tear meat from carcasses but could not crush bones. The skull of wolf-like dog (above) from near Long Pine has one pair of slicing teeth (tall teeth, center) and blunt, crushing molars for grinding bones.





Four-tuskers had a pair of ivory tusks at the tip of the lower jaw as well as the usual upper pair. Nebraska's most primitive four-tusker is *Gomphotherium osborni*, called the prod-tusker. Round, pointed lower tusks are characteristic of this species, the most common fossil elephant in the Valentine Formation.

sharp, foot-long tusks protruding forward from the lower jaw. I can almost imagine the first encounter between these giant "home boys" and the husky new kids on the block. Modern elephants tower so high above rhinos that they can pretend not to notice them, but mastodons and four-tuskers were built much lower to the ground and carried their heads low enough to look a rhino in the eye. What's more, as elephants go, Nebraska's first ones were small; we estimate that our 13- to 14 million-year-old adult female four-tuskers weighed little more than two tons and males only a ton or so more. Skeletons from higher in the Valentine Formation average much larger, with bulls commonly reaching five tons and cows three tons. The big rhinos, meanwhile, soon declined to extinction; a skull representing the last known *Peraceras* on record was collected from the top of the Valentine Formation near Springview.

Our first elephants were built for power, not speed. Rugged areas for muscle attachment on their massive leg bones signal a bulldozer-like ability to force paths through dense streamside forests. Four-tuskers must have been even better than modern elephants at opening up sunlit patches where grass could take root. Judging from their gently rounded molars, the four-tuskers themselves probably sought out soft nutritious foods such as fruit, juicy leaves and bark. They could crush food, but clearly could not grind it as efficiently as modern elephants can. Herds of four-tuskers must have been a major new ecological force on the Great Plains, permanently altering the habitats available for other forms of life.

From their fossilized bones alone we can only make educated guesses about the soft anatomy of four-tuskers. A free-hanging trunk as in modern elephants was out of the question; the lower jaw stuck out much too far to accommodate such an organ. A flexible upper lip and nose forming a lid for the lower jaw seems much more likely. Working in concert with the sharp-edged upper tusks and prod-like lowers, even a short proboscis could be a useful cropping device. Unlike a modern elephant which must kneel awkwardly to get its mouth in the

water, the short legs and long jaws of the four-tusker allowed it to drink merely by tilting its head down.

Less is known about the earliest mastodons than about the four-tuskers because their remains are more fragmentary and much scarcer. Mastodons did not become common until much later, during the Ice Age; they apparently thrived in cool forests while four-tuskers flourished in subtropical woodlands and savannas.

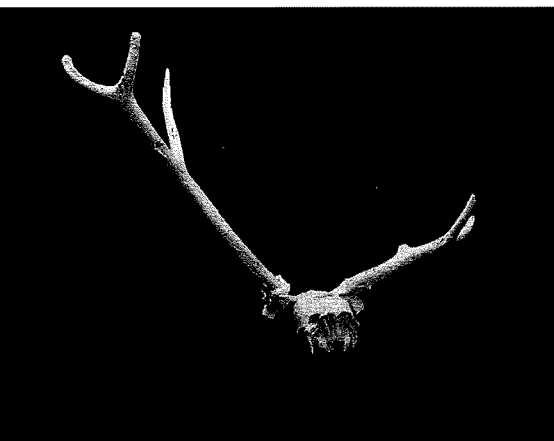
Excavations in the Valentine Formation have produced some of the most diverse arrays of fossil mammals known anywhere. Norden Bridge Quarry on the Niobrara River, for example, is less than 1 percent excavated but has already yielded 89 different species of mammals, including a four-tusker and a mastodon. No single fossil quarry on earth is known to have produced so many species of extinct mammals. To find diversity of that magnitude today we must go to tropical habitats in Africa. Only about 30 species of mammals live near Norden today. No complete skeletons have been found at the site, but thousands of bones, teeth, jaws and occasional skulls were deposited there in the channel of an ancient stream. The Miocene river must have been deeper and warmer than the Niobrara which rushes past the quarry today, judging from the alligator, alligator gar, alligator snapping turtle and giant salamander fossils found in the deposit.

Another major logjam of fossils in the Valentine Formation was uncovered during construction of the railroad bridge across the Niobrara River near Valentine during the early years of the 20th century. Horse remains of 10 different species are the most abundant large fossils at the site, while beavers (four species) are the dominant small mammals. A nearly complete skeleton of an ancestral pocket mouse (inevitably given the cute name *Cupidinimus* "Cupid's mouse" in honor of Valentine) was collected there too. Of the 31 species of hoofed mammals from the Railway quarries 19 (61 percent) are browsers, including four of the horses, two of the rhinos, a tapir, a chalicothere, both elephants and nine of the 14 cloven-hoofed species. An enormous variety of year-round leafy vegetation must have been available to feed the menagerie of forest animals.

However, when we count the number of individual animals represented by the fossils we find that more than 90 percent are grazers with tall-crowned, grass-eating teeth. That probably means grass occupied more area than trees by that time, and the grazers already tended to form large herds in contrast to the browsers, which probably lived in smaller family groups as they do today.

After horses, the most abundant grazing mammals from quarries in the Valentine Formation are miniature pronghorns called merycodonts ("cud chewing teeth") which stood little taller than jackrabbits and in fact must have looked remarkably like the mythical jackalope of Western folklore. Male merycodonts had sharp, forked spikes of solid bone perched directly over the eyes, but females were hornless. Horns of their closest living relative, the pronghorn, are in the same position but are present in both sexes and consist of a horny sheath fitted over a core of spongy bone.

Entire fossilized herds of merycodonts, with jaws and skulls of hundreds of individual animals, have been discovered in the Valentine Formation near Crookston, Nenzel, Crofton and Verdigre. Paleontologists believe those deposits resulted from local catastrophic mass death because the jaws fall into well-marked age groups exactly one year apart (e.g. 1-month-old, 13-month-old, 25-month-old and so on without intermediates). That distribution could only occur if all females in a herd gave birth in the same season each year and all the animals died over a short period — a few weeks or less. If either birth or death were spread out over the entire year then the ages of the fossils, as revealed by their teeth, would form a more-or-less continuous series rather



Skull of an extinct prongbuck from Hitchcock County with lopsided horns typical of *Ramoceros*. Other merycodonts had symmetrical horns. Vast herds of these tiny, antelope-like creatures grazed the Miocene savanna between 14 million and 11 million years ago.

than clumping at evenly spaced intervals.

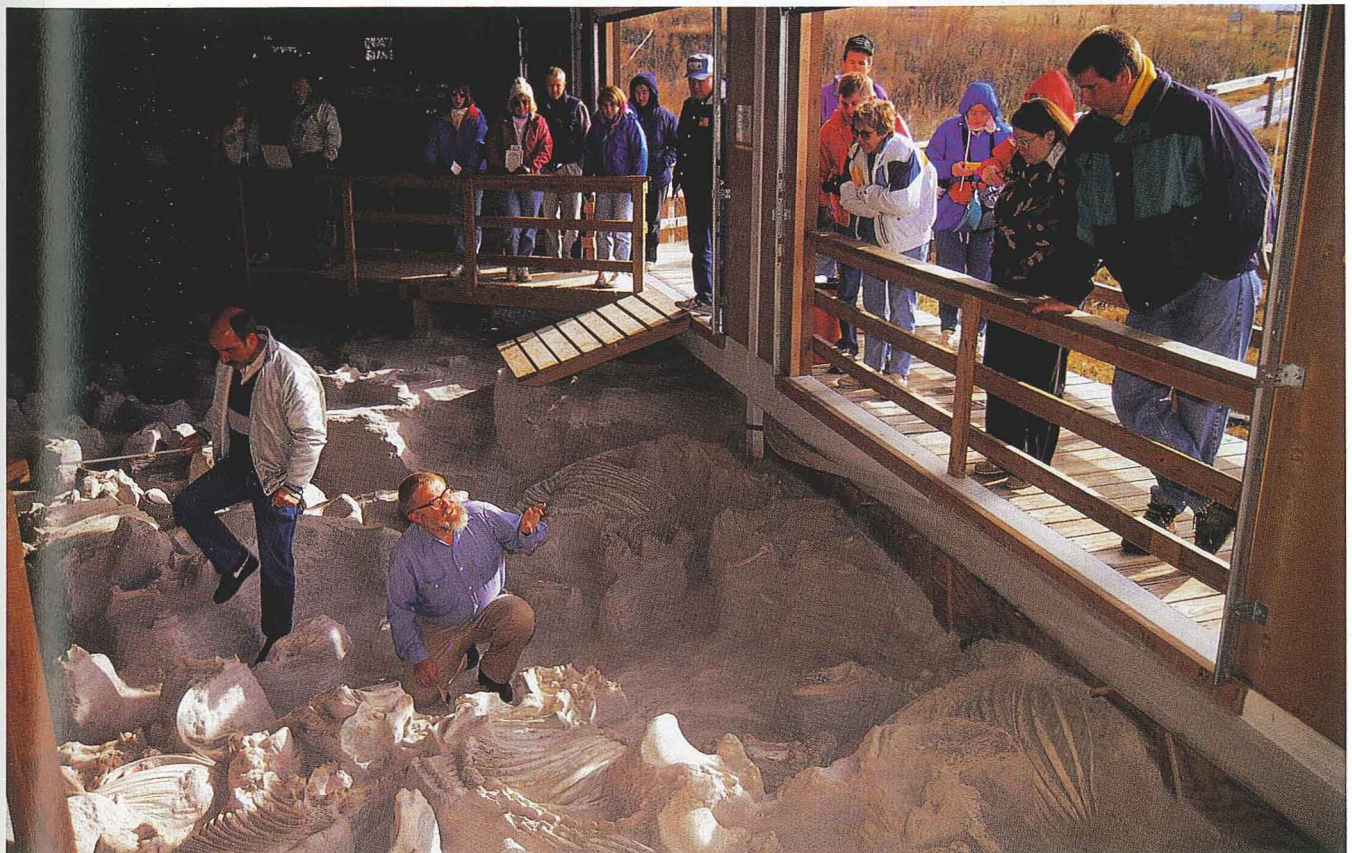
The most common merycodonts in the Niobrara River Valley have erect horns with a single fork, but farther south in the Republican River Valley deposits the same age as the Valentine contain abundant remains of a distinctly different member of the group that had evolved multi-tined, lopsided horns. Officially called *Ramoceros* or “many branched horns” that beast had one of the most unusual racks ever carried by a hoofed animal, living or extinct. One horn — sometimes the left, sometimes the right — is three or four times larger than the other; its main beam is nearly straight, extending upward and outward from the skull at an angle of about 45 degrees before branching into three or four forward-pointing tines. The smaller horn sticks almost straight out. When the first skull of this animal was discovered 90 years ago, scientists, naturally enough, thought the small horn had been injured in velvet before it reached full size. However, all *Ramoceros* bucks are built like that. Perhaps if they displayed from the side they looked bigger to their rivals.

Clarendonian: 11 Million Years Ago

An ash cloud from a huge volcanic eruption in Idaho 10 million years ago descended on a busy waterhole on the Nebraska savanna, enveloping entire herds of animals and creating a unique fossil deposit in what is now Antelope County. Today, those herds of perfectly preserved rhino skeletons lie with their legs tucked under their bellies or stretched out on their sides as if taking a nap. They look like real animals, unlike most fossils, which need extensive repair in a museum lab before they begin to make sense to anyone but a paleontologist.

The Ashfall rhinos were buried so quickly that they were preserved in three dimensions, often with remains of their last meals inside. Because the site is the only one like it known in the world, Ashfall was set aside as a state historic park. The fossils are left in the ground exactly as found, enclosed by a 32-foot

Ashfall Fossil Beds State Historical Park Superintendent Rick Otto and paleontologist Michael Voorhies (kneeling) explain the site to visitors. The Rhino Barn, which covers less than 1 percent of the fossil beds, shelters the exposed 10-million-year-old skeletons.



Front feet of five different Miocene horses from the Ashfall site contrast with the same bones of a modern horse (far right). The first three are typical three-toed horses with well-developed side hooves extending down on each side of the main hoof. Three-toed horses were probably good at cornering and might have spent considerable time in woody or marshy terrain. The next two are functionally single-toed, although only the fifth has lost all traces of the side hooves. Shriveled, vestigial side hooves are still present on the fourth. Like modern single-toed horses, ancient horses probably excelled at flat-out running on the open grassland. From left, the Ashfall horses are *Pseudhipparion*, *Cormohipparion*, *Neohipparion*, *Protohippus* and *Pliohippus*. The genus *Equus* includes all recent horses, asses and zebras.

by 64-foot building called the Rhino Barn, where paleontologists can work and the public can observe.

Barrel-bodied rhinos are the largest and most common fossils in the ash bed, and their skeletons are always above the other species in the ash deposit. Smaller creatures, including camels, horses, turtles and birds, lie at lower levels in the ash, indicating that they died before the rhinos.

The ash bed includes skeletons of five distinct kinds of horses, ranging from goat size to Shetland pony size. All have the tall-crowned teeth of grass-eaters and long, slender legs. Three of the Ashfall horse species are good examples of the "three-toed horses," having a somewhat smaller toe and hoof on either side of the main hoof. The side toes in those species were strongly developed and probably gave added traction when the animals maneuvered over soft or overgrown terrain. The other two Ashfall horses were functionally single toed, like modern horses, although some skeletons have weakly developed side toes on one or more feet. Such "vestigial organs," as Darwin called them, tend to be eliminated by natural selection as soon as their function is lost. The Ashfall sample of fossil horses contains some individuals that have already lost the side toes and some that still have them, a fossil record of the transition between the ancient three-toed condition and the single-toed state of all modern horses. At least one "missing link" is no longer missing.

Another site from that period, Pratt Slide in Brown County, is much less impressive to the layman than Ashfall, but has been at least as informative to the scientist. Pratt Slide is a section of ancient river channel that filled over a long period with sediment and the remains of animals that had died nearby and





A huge skull found along the shore of Lake McConaughy proved to be that of an *Epicyon* (“top dog”). That group of extinct bone-crushers included the largest dogs that ever lived. The skull of a 130-pound St. Bernard (left) is dwarfed by the bear-size fossil.

had washed or fallen in. The fossils are jumbled and fragmentary and not much to look at, but give paleontologists a much more complete inventory of species alive then. All the species found at Ashfall, open country grazing animals, are present along with a host of leaf-eating browsers such as tapirs, giant horses, shovel-tusked elephants and three-horned deer. There are a few remains of sabercats, dogs and other predators, plus fossils of smaller animals such as hedgehogs, shrews, moles and mice. In all, 80 species are represented.

While no skeletons of large predators have been found so far at Ashfall, and only a few specimens at Pratt Slide, remains of predators are the most impressive feature of the Shoreline site at Lake McConaughy. Herbivore remains at the site consist mostly of teeth and some large bones conspicuously gnawed and splintered. Paleontologists suspect the site was once a denning area where various carnivores leisurely gnawed away at the bones of their prey.

Skeletal remains, including a perfect skull, were found of at least seven *Epicyon*, which means “top dog.” At an estimated weight of nearly 300 pounds, it is the largest known member of the dog family. There were also at least eight individuals of a smaller species of dog with wolf-size jaws and teeth, but legs no longer than those of a coyote.

As imposing as the dogs were, the cats were even bigger. A species of *Nimravides*, a quarter-ton sabertooth cat, previously known only in Florida, were found at the Lake McConaughy site. There were also smaller, leopard-size sabertooths, early *Barbourofelis*, with serrated fangs still capable of slicing a finger after 90,000 centuries in the ground.

Sabertooths and the Last Rhinos

Nebraska’s savannas continued to become drier and grassier during the next chapter of our story. Among the forest dwellers that didn’t survive the end of the preceding Clarendonian mammal age were hedgehogs, browsing horses and camels, musk deer, oreodonts and beardedogs. Alligators and “slingshot-horned deer” also disappeared from the Nebraska fossil record at that time, shortly after 9 million years ago, but they continued to thrive along the Gulf Coast where the climate remained wetter.

Our good alligator holes may have dried up, but the abundance of giant tortoise remains proves that it rarely if ever froze in the central Great Plains during the last 4 million years or so of the Miocene. In addition to the familiar

thin-shelled species we begin finding smaller fossil tortoises with rugged, deeply sculpted shells and Popeye-like overdeveloped forearms. They are the gopher tortoises (*Gopherus*) that, unlike their giant relatives, could dig deep burrows to escape hostile conditions above ground.

Hemphillian: 8.5 Million Years Ago

Mammals that survived the extinctions that began the Hemphillian evolved into some of the most spectacular creatures that ever made their homes on the plains. For example, the huge jaw of a new kind of “four-tusker” was found by Alex Keith on his Frontier County farm in 1926. Erwin H. Barbour coined the scientific name *Amebelodon*, meaning “shovel-tusker” based on its flat lower tusks. The six-foot-long jaw, now on display in Morrill Hall, is larger than that of any other known land animal, including dinosaurs (The largest known dinosaur jaw, that of *T. rex*, measures just over four feet.).

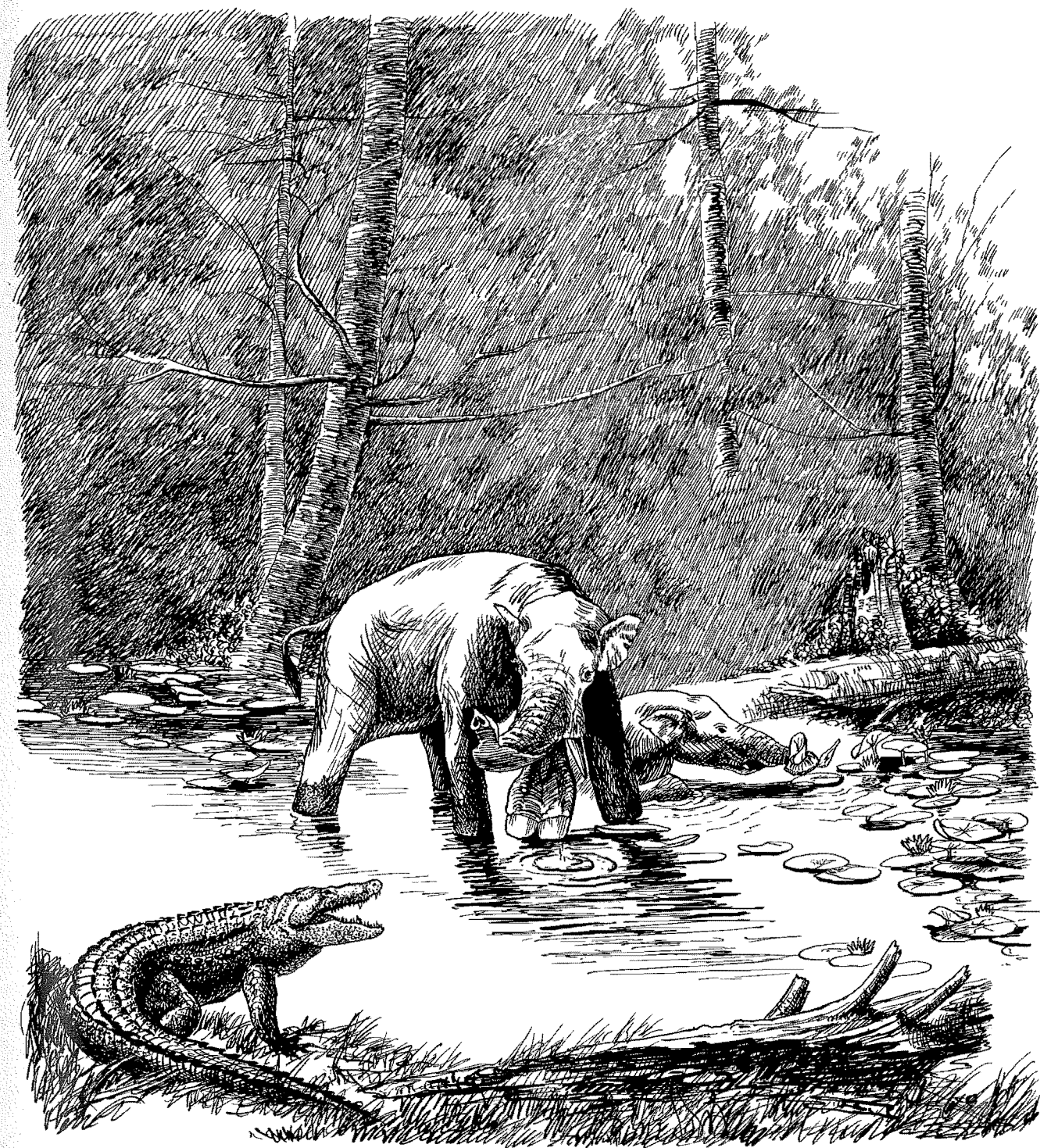
Excavations at the *Amebelodon* site, or Cambridge Quarry, during construction of Medicine Creek Dam in the late 1940s uncovered thousands of additional fossils but none more stunning than the perfectly preserved skull of a huge sabertoothed carnivore. With its extraordinarily sharp, thin canine teeth and a long, protective flange at the front end of the lower jaw, it was eventually described as a new genus, *Barbourofelis*, or “Barbour’s cat.”

Detailed research on the braincase of *Barbourofelis* shows that it was not closely related to cats at all but was the last member of an extinct family of small-brained, short-legged ambush predators. All fossil deposits where *Barbourofelis* has been found contain abundant rhino and elephant bones, and we may speculate that its exceptionally long sabers might have been used to penetrate the thick hide of such large prey.

The Cambridge Quarry yielded remains of two kinds of rhinos. Most abun-

The first shovel-tusked elephant fossil ever discovered, this lower jaw came from late Miocene gravel deposits near Cambridge in 1926. The largest known jaw of any land animal, it is being prepared for display in Morrill Hall by Chief Preparator Gregory Brown. The presence of only one molar, the wisdom tooth, on each side of the jaw shows the animal was an adult. Except for larger size and flattened lower tusks, these huge elephants were similar to the older prod-tuskers, probably their ancestors.





dant is a barrel-bodied species similar to the one at Ashfall fossil beds but with adults averaging about a quarter ton heavier. Less common but still represented by good material, including a magnificent skull, is the normally proportioned but hornless rhino called *Aphelops* ("smooth face"), which is also much bigger than its Clarendonian ancestors. Those strikingly different beasts, the "Mutt and Jeff" of the rhino world, continued to range over the Great Plains until the end of Hemphillian time when both became extinct.

Surveying a collection of hoofed mammal remains from Hemphillian deposits, we recognize many familiar shapes. Horses are still the most common fossils at most sites but rather than eight or 10 species we usually find

The last Nebraska alligator and a "scoop-tusked" elephant face off in a drawing based on fossils from a 9-million-year-old lake deposit in Cherry County. Later beds have not yielded remains of either the scoop-tusker, *Platybelodon barnumbrowni*, or the alligator, *Alligator mefferdi*. It may have become too dry for them by the close of Clarendonian time.

only four or five. The surviving species, all grazers with tall-crowned teeth, tend to be larger than their predecessors. The greyhound-size "lawn mower" horse *Calippus* of earlier times, for instance, had evolved into a sturdy animal almost as big as a Shetland pony, and its remarkable expanse of grass-clipping front teeth had widened to more than four inches across in specimens found in the Cambridge Quarry.

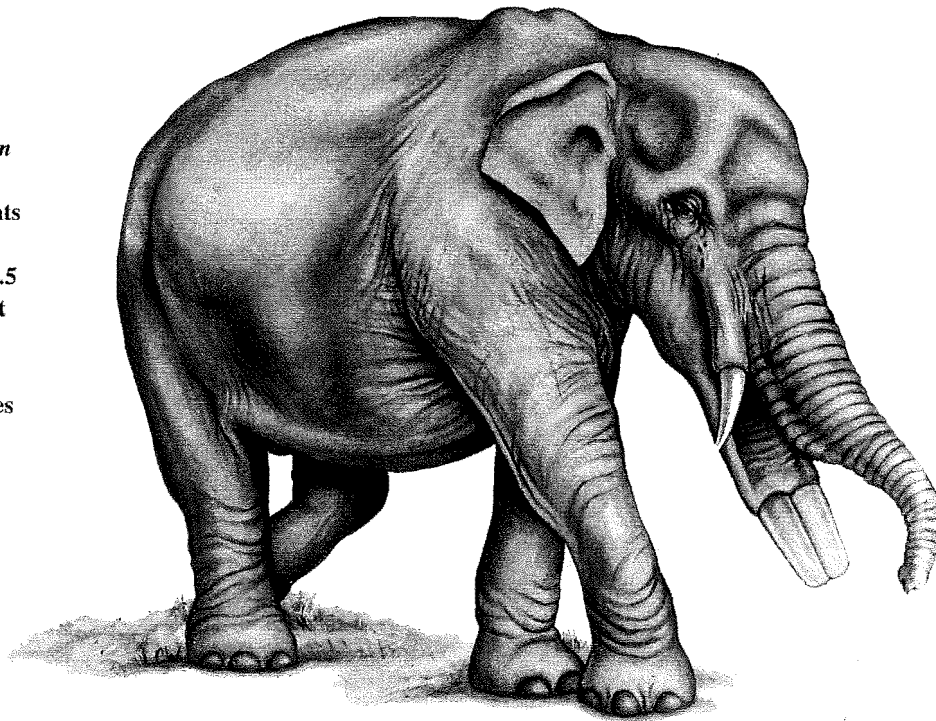
As in horses, diversity in the camel family decreased (three species can be sorted out in most faunas) while average size increased. The largest, *Megatylopus*, reached and then surpassed the size of modern Old World camels during the 4 million year time span of the Hemphillian. Giraffe camels have been reported from the Hemphillian of Texas, but we have not definitely recognized them in rocks of that age in Nebraska; there may not have been enough tasty trees left up here to keep them well fed.

Peccaries, pronghorns and three-horned deer are other even-toed, hoofed animals that played important roles in the savanna ecosystem of late Miocene Nebraska. They, too, show trends toward larger size during the interval except for the three-horn, which got smaller during the last half of the Hemphillian before becoming extinct at the end. A mass-death assemblage of the ancestral pronghorn *Texoceras* collected from a quarry near Oshkosh shows that those animals were forming large herds on the High Plains 7 million years ago.

Not all the large vegetarians had hooves. Two kinds of South American ground sloths somehow reached North America during the Hemphillian — probably by island-hopping, since the Isthmus of Panama did not connect the continents until much later. Those unlikely looking clawed creatures continue to appear sporadically in Nebraska fossil deposits until the end of the Ice Age.

Besides *Barbourofelis*, which became extinct about halfway through the Hemphillian, large meat-eaters of the era include a wolf-size bone crusher, *Osteoborus*, our first modern-type bear, *Indarctos*; and an enlarged version of the big cat, *Nimravides*, that we already encountered near its den at Lake McConaughy. Late in the Hemphillian another fierce predator arrived from Asia, an ancestral wolverine.

The shovel-tusked elephant *Amebelodon* as it may have looked in life. Shovel-tuskers were the most common elephants on the plains during the Hemphillian mammal age between 8.5 million and 4.5 million years ago, becoming extinct just before the beginning of the Ice Age (Pliocene and Pleistocene). They might have used their tusks to scrape branches and bark from trees, or used them as dredges to scoop up water plants.



GIANTS OF NEBRASKA PALEONTOLOGY

By Michael R. Voorhies, University of Nebraska State Museum

Erwin H. Barbour and Morris F. Skinner, whose careers spanned more than a century, from horse-and-buggy days to the four-wheel-drive era, left an indelible stamp on the history of geology and paleontology in Nebraska: Barbour as the "Father of Elephant Hall" and Skinner as our greatest field paleontologist.

Barbour (1856-1947) is best known as the force behind the design and construction of Morrill Hall — often called Elephant Hall after its most famous gallery — on the University of Nebraska campus in Lincoln. As director of the museum from 1891 through 1941, Barbour organized annual expeditions to collect fossils. In the early years he participated actively in the field work, especially if there were elephant skeletons to be unearthed.

Barbour studied paleontology at Yale under famous dinosaur maven O.C. Marsh, and perhaps his early exposure to gigantic fossils carried over to his work in Nebraska, where dinosaurs are in short supply but bones of extinct elephants are abundant.

By the 1920s, the old red brick museum building was overflowing with fossils. An innate sense of showmanship inspired Barbour to mount the forequarters of an enormous mammoth, collected near Wellfleet in 1922, as an archway through which visitors passed when entering the museum. That convinced the public that a new building was needed, and by 1926 funds were appropriated for the construction of Morrill Hall. Highlighting the new museum was a spacious central gallery featuring the Proboscidea — elephants and their extinct relatives. Elephant Hall now contains not only the famous "parade" of 11 skeletons of elephants, mammoths, mastodons and four-tuskers, but also proboscidean fossils from 90 of the 93 Nebraska counties.

Barbour described and named 15 new species of extinct elephants during his long career, usually illustrating his scientific publications with drawings and photographs. A talented artist, he also was fond of sketching imaginative but plausible portraits of vanished species as they might have looked in life. The Ice Age mammoths and mastodons from Nebraska were similar in most respects to those already known from the eastern states, but Barbour's discoveries of far older and

more primitive elephants in the Miocene bedrock of the state proved a revelation. Perhaps the most bizarre of them all were the shovel-tuskers and scoop-tuskers with their wide, flat lower tusks, but other gomphotheres (four-tuskers) also must have been fantastic looking beasts.

One of Barbour's most important discoveries was how the elephants changed with time. Near Ainsworth, in Devil's Gulch (nicknamed the Grand Canyon of Elephant Evolution) he collected the remains of two new species of primitive, prod-tusked four-tuskers from older layers near the bottom of the gulch and a perfect-tusker, *Eubelodon*, which had lost its lower tusks, from beds closer to the top of the 250-foot-deep canyon.

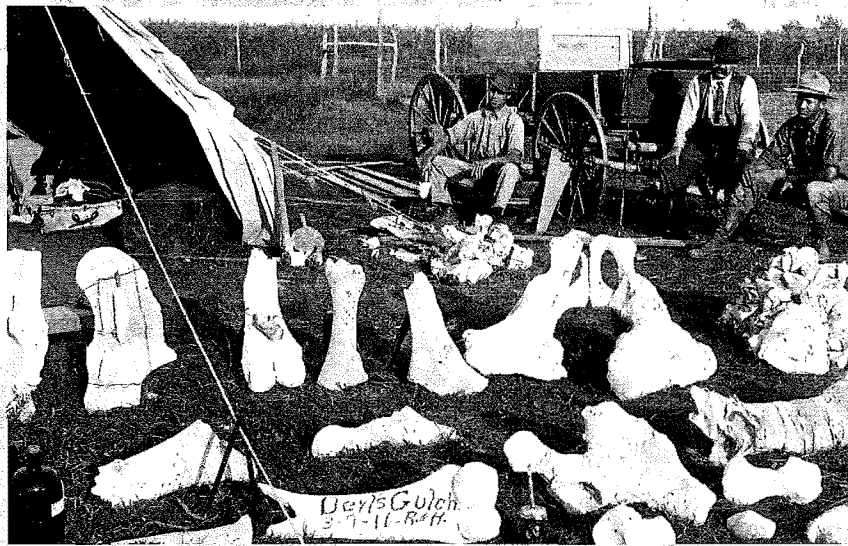
Less well known to the public but legendary among paleontologists, Morris Skinner (1906-1989) was the premier bone hunter of them all. Working for the Frick Laboratory of the American Museum of Natural History for more than 50 years, he made one of the largest

dividual animals, even entire populations of some species, became available to study for the first time thanks to Skinner's efforts. The existence of the "three-horned deer," for example, was only tenuously known from a few fragments before he collected a perfect skull, jaws and partial skeleton of the beast from Devil's Gulch in 1928.

Skinner knew better than anyone that fossils themselves, no matter how large, complete or rare, are of no value without associated data, and he made detailed stratigraphic sections, "rock pictures," for every site and noted to the foot exactly where each fossil was found. His cataloging system is a model of its kind.

He was always on the lookout for clues that previous generations of bonehunters had overlooked. In the central Niobrara Valley, for example, most exploration had concentrated on the Valentine beds — soft, easily gullied river deposits with abundant petrified trees and mammal remains. Above the Valentine, protecting it from erosion, was a concrete-like sandstone bed named

the Cap Rock by Skinner. With its broken bones of horses, camels, rhinos and other grazers, it was thought to record the closing chapter of a great drying out of the climate. Alligators and other "jungle" animals supposedly were already extinct by this time. Skinner's discovery of the Xmas and Kat quarry channels overturned this interpretation. Noticing that water-loving plants like sumac grew much better in some parts of the Springview Table than



Field party with elephant bones at Devil's Gulch, March 9, 1916.

and best documented collections of fossil mammals ever assembled for any institution. His formal training was in geology; he received his degree in 1932 from the University of Nebraska where Barbour was among his teachers. His paleontological career began earlier, when he and a high school friend prospected the canyons of their native Brown County. In 1927, they located a rich deposit of rhino bones and collected specimens for museums in Denver, Berkeley and New York as well as two full skeletons still on display at Morrill Hall.

Along with one or two assistants, Skinner systematically explored the canyons of the Niobrara River Valley, locating dozens of world-class fossil deposits. Hundreds of in-

others, he dug in one of the extra-healthy patches of vegetation and discovered a deep, narrow channel cut into the Cap Rock and filled with moisture-trapping sand, gravel and bones — the jungle animals had survived along the rivers.

As a fledgling paleontologist, I remember sitting on the rocky floor of one of the Xmas-Kat quarries and hearing Skinner tell about his first look at the gleaming skulls of unknown creatures at the bottom of the channel: giant three-toed horses, browsing rhinos, tapirs, spike-headed "hogs" (peccaries) so strange that they still have not been given scientific names, wholly new kinds of sabertooths, all jumbled together on a gravel bar of an ancient river. It must have been quite a sight.