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Article Summary: In the middle of the Pliocene Epoch about 3 million years ago many kinds of large animals roamed Nebraska land during an extended warm spell. Then glaciers entered the state from the northeast.

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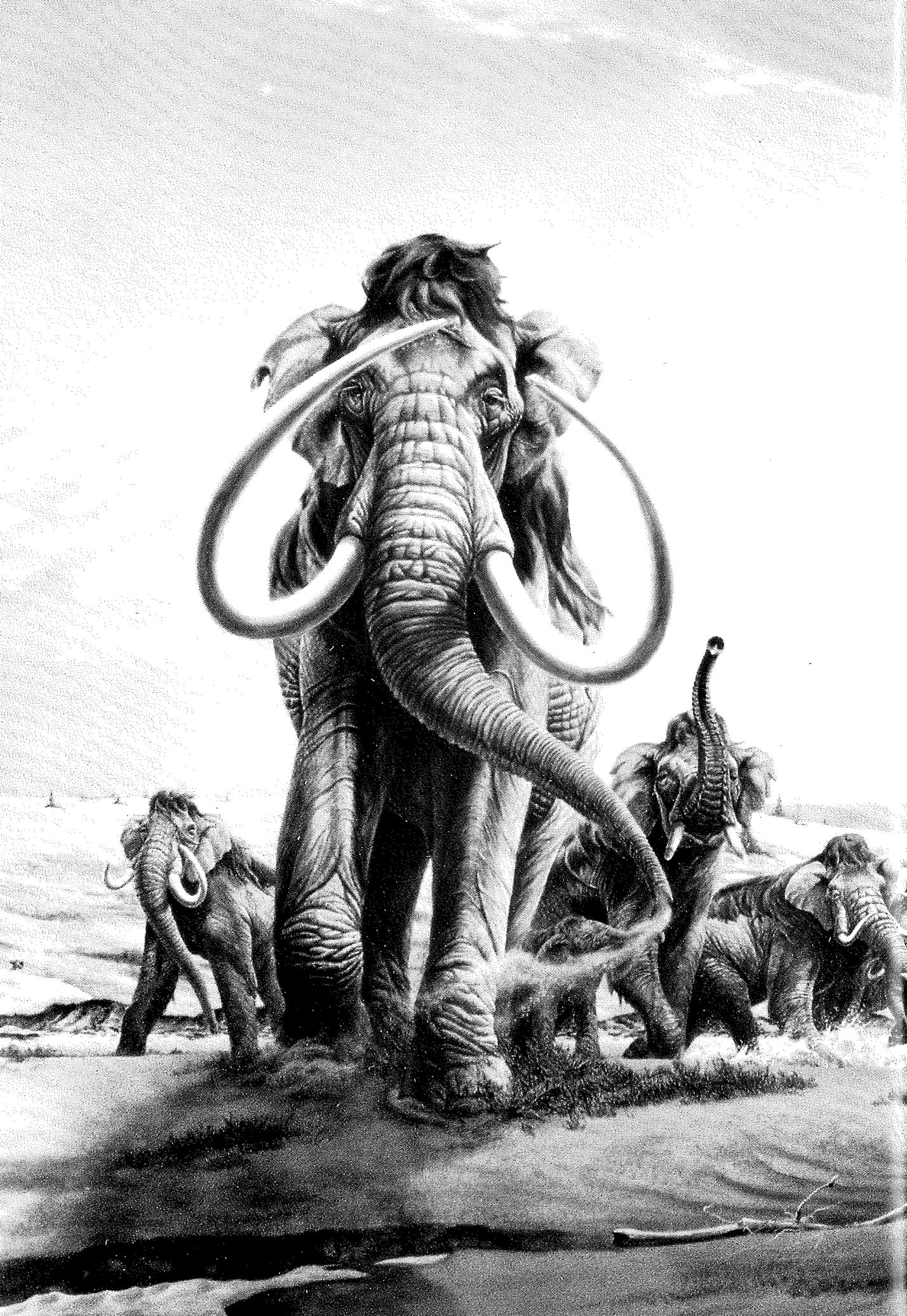
Names: E H Barbour, Morris Skinner

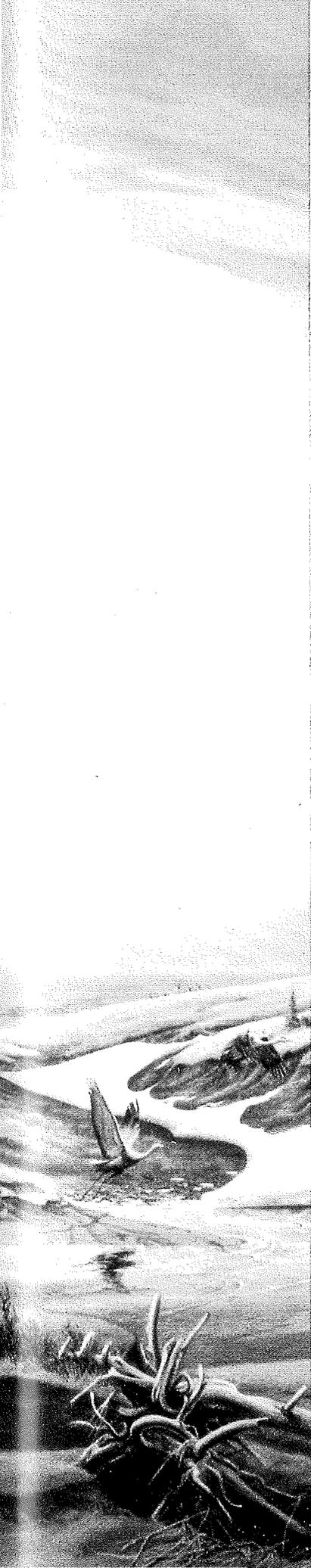
Geologic Time: Pliocene Epoch

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Photographs / Images: image of ice age mammoths in the Platte River Valley, mastodon tooth, University of Nebraska paleontologists collecting camel bones in Lisco Quarries in 1939, *Stegomastodon* skeleton from near Broadwater, beaver skulls, gopher tortoise found north of Ainsworth





PART THREE

THE ICE AGE

Nebraska's last extended warm period preceded the plunge into the Ice Age. The first glacier covered the state a little more than 2 million years ago, and the last glacier stopped at the Missouri River 18,000 years ago. It was a period of gigantism, characterized by huge mammoths and bears and the largest true cats that ever lived.

Ice Age mammoths rumble across Nebraska's Platte River Valley.



Giant Camel

CHAPTER FIVE

Zebras and Giant Camels

A Greenhouse World Feels a Big Chill



Mastodon tooth

By Michael R. Voorhies
University of Nebraska State Museum

CONCERN ABOUT POSSIBLE GLOBAL WARMING in the future has spurred scientists to search the fossil record for clues about what a “greenhouse” world would be like. Mounting evidence from around the world points to the middle of the Pliocene Epoch, about 3 million years ago, as the earth’s most recent extended warm spell.

In Nebraska, fossil beds dating between 3.5 and 2.5 million years old give use a richly detailed picture of the animal life, large and small, that enjoyed the last long stretch of frost-free climate. Older, early Pliocene deposits hint at cooler temperatures, and by late Pliocene times, 2 million years ago, glaciers already had pushed their way into the northeastern corner of the state.

Lisco Quarries

One cold autumn day in 1936, a goose hunter hunkered down in a sandy gully in the tableland above the North Platte River in Garden County felt something poking him in the back. Trying to make his blind more comfortable, he pulled the offending “rock” out of the bank only to find that it was the sharp end of a large, petrified bone. As so often happens in paleontology, that accidental discovery led to something bigger: the first of the Lisco camel quarries, the pre-eminent early Pliocene sites in Nebraska.

A museum crew working nearby was notified, and soon paleontologists were combing the eroded pasture for more fossils. Much to E.H. Barbour’s

Exhibits Supervisor Debra Meier with giant camel skeleton at Morrill Hall.

delight, the crew quickly located a logjam of exceptionally large camel bones. Bits and pieces of huge camels had turned up in odd corners of the state for years, but now, for the first time, there was enough material for an entire skeleton. Soon the museum workroom was crowded with the fencepost-like limb bones of the new camel — officially christened *Gigantocamelus* by Barbour and his assistant C.B. Schultz — and by 1939 a full skeletal mount was on exhibit in Morrill Hall, where it can still be seen.

Impressive as it is, this 11-foot-tall specimen actually is a small *Gigantocamelus* because nearly all the leg bones used in constructing it are from females. Later collections from Lisco show that males averaged 20 percent taller than females and were much heavier. We conservatively estimate the weight of an adult bull *Gigantocamelus* at well over a ton, heavier than a large draft horse and about twice as heavy as the largest living camels. Perhaps their most impressive feature, besides overall size, was the pair of *Tyrannosaurus*-size canine teeth sported by males and probably used in combat during the breeding season.

The single most productive Lisco locality, studied recently by University of Nebraska graduate student Elise Schloeder, is an ancient lakebed that yielded the remains of more than 70 individual giant camels, primarily young adult males. Scattered among the camel bones are fossils of at least 40 species of smaller animals that lived in or near the Lisco lake. Bullheads, minnows, sunfish, frogs, pond turtles and snakes are for the most part identical or closely related to species that still live in the North Platte Valley, indicating that the early Pliocene climate was not much different than today's. For the first time in our long journey through the Age of Mammals we encounter a major fossil locality where no tortoise bones have been collected. Absence of those warmth-loving creatures may signal the arrival of freezing winters in the Panhandle for the first time.

University of Nebraska paleontologists excavated the Lisco quarries in 1939. Remnants of more than 70 giant camels were collected from a 3.5-million-year-old lakebed along with large bone-crushing carnivores that may have caused the scattering of the camel carcasses seen here.



GLACIAL CALLING CARDS

By Michael R. Voorhies, University of Nebraska State Museum

We know for sure that glaciers once covered eastern Nebraska because they left their calling cards behind: big chunks of grooved and polished Minnesota bedrock that could have gotten here no other way. Pebbles, cobbles and boulders — some bigger than a station wagon — litter eastern Nebraska. Farmers east of U.S. Highway 81 haul those Ice Age mementoes out of their fields, only to see new ones punch up through the soil again the following spring.

Glaciers are highly destructive — like large bulldozers they crept into the state, stripping and grinding away much of the fossil record of earlier periods.

The first glaciers to enter Nebraska a little more than 2 million years ago were moving

uphill, pushed by the weight of snow accumulating far to the north. Ice moves like toothpaste — the main squeeze is applied in the thick upstream area. Unlike mountain glaciers, which are pulled downslope by gravity, continental glaciers move by spreading, and are capable of moving uphill at the edges.

Rather than moving south until melting caught up with it as it did, for example, in Iowa and Missouri, the ice in Nebraska also moved toward the west. Its westward movement was limited by the fact that the land elevation rises toward the west at 8 to 10 feet per mile.

The ice, a slow-moving fluid, eventually pooled at an elevation of about 1,650 feet in Knox County. Across the border in Antelope

County the easily eroded Ashfall fossil beds are 1,700 feet above sea level, only 50 feet higher than they had to be to avoid destruction by the ice.

But ice is also constructive. It gave us a varied landscape and some of the richest farmland in the world, covering thousands of square miles with freshly ground up rock having all the nutrients still intact. Some of the material blew beyond the ice margin to form that remarkable sediment called loess. This silty material, both glacial and nonglacial, is good not only for farming but also for burying mammoths like Archie, the largest fossil elephant ever found, which is now on display in Elephant Hall at the University of Nebraska State Museum in Lincoln.

Burrowing rodents, some still in their dens, are common fossils at Lisco.

Pocket gophers, pocket mice, kangaroo rats, ground squirrels and voles all are abundant. Notably absent are beavers of any kind and warm-climate indicators such as cotton rats. The most spectacular Lisco rodent is undoubtedly the giant groundhog *Paenemarmota* ("the ultimate marmot"), a 50-pound animal with large claws that might have excavated the largest fossil burrows found at the site. Small, but nonetheless important because it pins down the age of the Lisco bonebed, is the pygmy muskrat, *Pliopotamys minor*. Less than half the size of a modern muskrat, this Asian immigrant was the founding species of a lineage that continued to thrive in marshes across North America for the next 3 million to 4 million years, gradually increasing in size and adding more wrinkles to its accordion-pleated teeth.

A deer, a peccary, a prongbuck and two kinds of camels smaller than *Giganotocamelus* complete the roster of even-toed hoofed animals found at Lisco, and only one odd-toed species, the single-toed horse, *Equus simplicidens*, is present. The other herbivores in the fauna are both browsers, a mastodon and a small species of the "great claw" ground sloth, *Megalonyx*. A skeleton of the latter from Lisco is on display in Morrill Hall.

Bones from the Lisco quarries often bear the imprint of massive carnivore teeth, and many of the giant camel carcasses appear to have been dismembered by scavengers. Two extinct members of the dog family probably were responsible for most of the damage. *Canis lepophagus*, whose name means "rabbit-eating dog," is an ancestral coyote only slightly smaller than today's coyote and probably similar to it in lifestyle. A much larger canid called *Borophagus* ("greedy eater") must have been a peculiar-looking beast with its massive hyaena-like head carried on the rather slender body of a short-legged wolf. Bone-filled fossil droppings clustered around the Lisco camel carcasses suggest that both types of dogs were effective scavengers. Whether *Borophagus* could kill a giant camel is debatable, but another Lisco carnivore appears equal to the job — the lion-size sabercat *Ischyrosmilus*. To minimize damage to its finely serrated sabers this animal probably avoided the larger bones of its prey, but it looks well equipped for cutting out large chunks of meat from a carcass before abandoning it to the dogs.

The Lisco bonebed with its mighty camels and mini-muskrats is sandwiched between thick beds of gravel called the Broadwater Formation, which includes hardrock boulders bigger than a human head. Geologists Jim Swinehart and Bob Diffendal of the University of Nebraska Conservation and Survey Division followed the trail of big rocks back to a source in the Medicine Bow Mountains of Wyoming. Meltwater from glaciers on the high peaks must have roared down what is now the North Platte Valley at intervals during the early Pliocene, carrying large pieces of ancient bedrock much farther east than they had ever come before. For the next 1 to 2 million years, large volumes of sand and gravel continued to sluice down from the Rockies onto the Plains, where they filled a broad valley stretching southwest to northeast across Nebraska.

Dozens of significant fossil sites have been found in post-Lisco Pliocene deposits. The largest, another lake and marsh accumulation, was discovered near Broadwater in 1936. The largest fossil quarries ever operated by the museum were excavated there between 1937 and 1941 by WPA laborers and supervisory paleontologists. Literally tons of fossils were recovered from the Broadwater quarries, providing a detailed picture of the wildlife in a Morrill County wetland 3 million years ago.

Broadwater Quarries

The most impressive fossil from Broadwater is the complete *Stegomastodon* skeleton now on exhibit in Morrill Hall. That old male, with enormous tusks and worn-out molars, may have become mired in soupy marsh sediments. His bones show symptoms of an arthritis-like disease that may have crippled his movements. *Stegomastodon* was the last member of the four-tusker family of elephants — all others had become extinct much earlier by the end of the Miocene. Judging from their short lower jaws, stegos almost certainly had long, free-hanging trunks that enabled them to feed on grasses at ground level. Their complexly folded, cement-covered grinding teeth also support that interpretation.

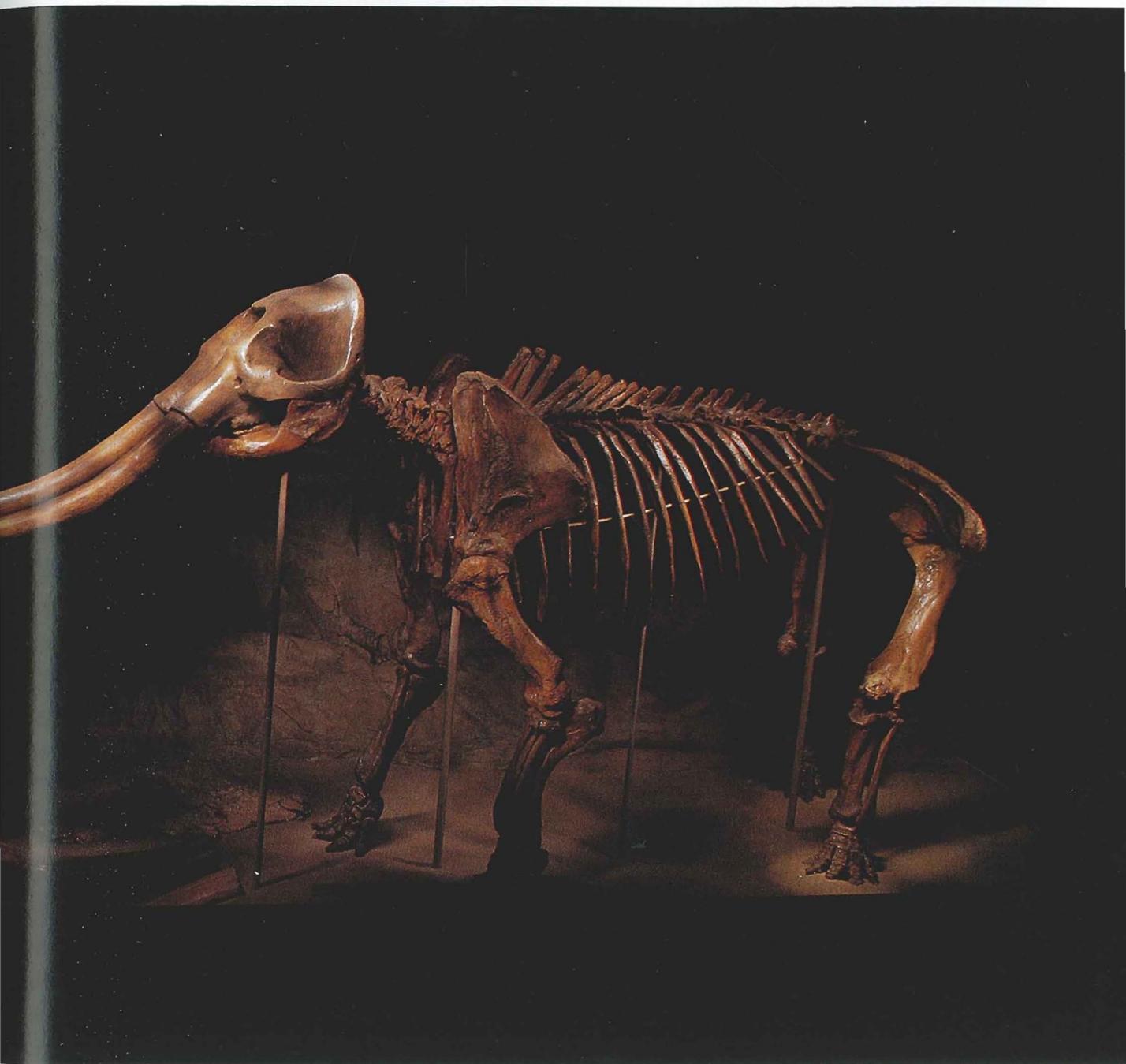
By far the most common grazers in the Broadwater collection, however, were horses (*Equus simplicidens*) with bones and teeth so similar to those of the largest living species of zebra that we refer to them as zebra-like horses. Artists attempting to portray scenes from the early Ice Age are almost certainly justified in putting stripes on Pliocene horses, even though actual fossil hides have not been found.

The original discovery of *Equus simplicidens*, the first full-sized horses, was made at Mount Blanco, Texas, in the 1890s. Since then their distinctive bones and teeth, along with those of its usual companions *Gigantocamelus* and *Borophagus*, have served as guide fossils for the Blancan mammal age (Pliocene) across North America.

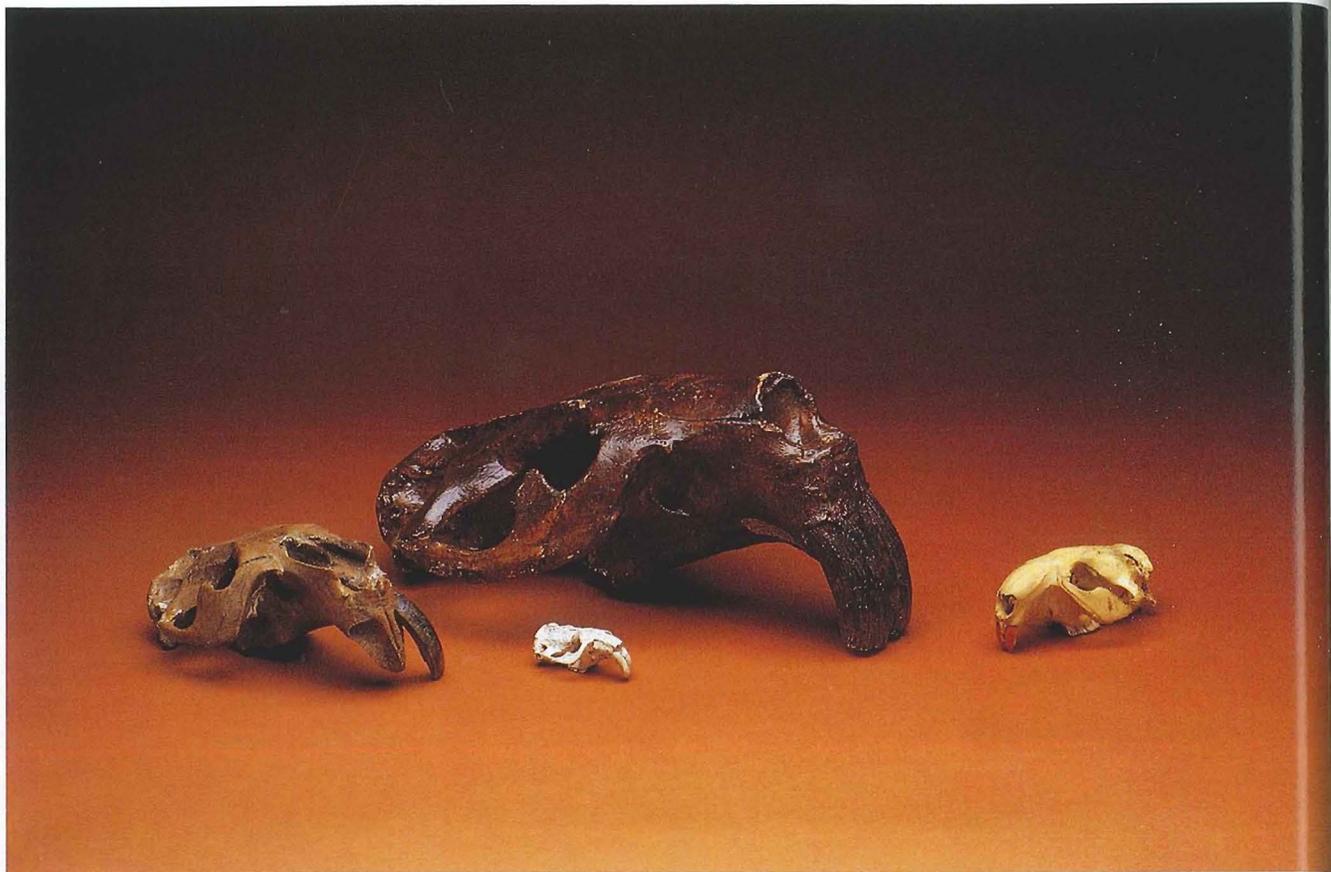
The Broadwater sample of the species contains more than 250 individuals and is the largest in existence. All surviving members of the horse family, including zebras and asses as well as wild and domestic horses, are thought to have descended from *Equus simplicidens* that migrated to Asia and eventually to Europe and Africa during the Pliocene. Remains of a much smaller horse, the goat-sized *Nannippus* (“dwarf horse”) are rare at Broadwater. As the last survivor of the great Miocene diversification of three-toed horses, *Nannippus* apparently preferred warmer climates because it is much more common in Florida, Texas and Arizona than in the northern Plains.

Next in abundance after horses at Broadwater are camels, but llamas greatly outnumber giant camels in contrast to what was seen at Lisco. An additional type of ground sloth, a 1,000-pound knuckle-walker called *Glossotherium*





This *Stegomastodon* skeleton was collected from 3-million-year-old marsh deposits near Broadwater in Morrill County. These heavy-bodied, short-limbed animals became extinct when the taller, more elegant mammoths reached North America. Fossils of this extinct elephant have been found in Pliocene-age deposits throughout Nebraska.



Beaver skulls range from muskrat-size to bear-size. The smallest and oldest skull is a 14-million-year-old specimen from the Valentine Formation (middle Miocene). The two largest skulls, from the Ice Age, are of the 3-million-year-old *Procastoroides* from Pliocene-age beds at Broadwater and the *Castoroides*, a giant beaver found in the middle Pleistocene Hay Springs quarries. The skull of a modern beaver is at right.

(“the beast of the tongue”), occurs along with *Megalonyx* at the site.

Large predators prowled the edges of the waterholes at Broadwater as they had half a million years earlier at Lisco. The great bone-crusher *Borophagus* was still the most common carnivore, and coyotes are abundant. Not just one, but two types of sabertooth cats have been identified at Broadwater — the larger *Ischyrosmilus* resembles its Lisco counterpart, but the leopard-size *Megantereon* is new. Later in the Ice Age it will give rise to the much larger *Smilodon*. Two carnivores with close relatives living today in the jungles of South America add variety to the fauna — the giant river otter *Satherium* and the terrier-size, weasel-like beast *Trigonictis*, related to the tayra.

A new type of giant beaver, *Procastoroides*, is represented by many skulls and jaws from the quarries. Muskrats and voles belonging to more advanced species than those at Lisco also are common at Broadwater, as are rodents, such as cotton rats (*Sigmodon*), which show that the climate had warmed considerably since earlier in the Pliocene. This impression of mid-Pliocene warmth is reinforced by the presence of giant tortoise remains.

Almost exactly the same age as the Broadwater deposit but producing an even greater variety of warmth-loving wildlife are the Sand Draw fossil beds near Ainsworth. In addition to a wealth of microfossils, excavations there produced some surprises, including an entire herd of *Stegomastodons*, including babies, found and collected by Morris Skinner, fossil badgers indistinguishable from present-day badgers — a most unusual instance of a mammal species remaining unchanged for more than 3 million years — and gopher tortoises that live only in the southern United States and Mexico today.

The climate apparently was still mild 2.5 million years ago judging from abundant fossils recovered from late Pliocene gravel beds in northern Antelope County. Big tortoises were still lumbering around, cotton rats flourished and three other heat-seeking mammals — armadillos, tapirs and small carnivores

called ringtails (*Bassariscus*) — had joined an animal parade that also included virtually all the groups found at Broadwater and Sand Draw.

Evolutionary changes can be detected in many of the mammal lineages: *Equus simplicidens* had evolved into a larger zebra called *Equus idahoensis* by the late Pliocene; muskrats were larger; real jackrabbits (*Lepus*) had evolved from smaller ancestors. All in all, vertebrate life was more diverse (at least 100 species) in the late Pliocene than it had been since the late Miocene 3 million years earlier.

The only hint that trouble might lie ahead for the greenhouse paradise is the sudden influx of new types of voles from the Arctic, including the first bog lemmings (*Synaptomys*) and the now-extinct *Guildayomys*, *Hibbardomys* and *Loupomys*. When the first glacier finally inched its way into northeastern Nebraska about 2.2 million years ago, those fast-breeding little northerners were among the few members of the resident fauna to take the disaster in stride. Vast numbers of their distinctive teeth and jaws recently were collected near Center in Knox County from outwash deposits of the first glacier.

Along with them are remains of cool-water fish such as trout, white suckers, walleyes and northern pike. No remains of tortoises or any other warmth-loving species have been found. The only large mammals that apparently lived near the edge of the ice sheet were giant camels, horses and mastodons. By 2 million years ago when a layer of volcanic ash was blown out onto the Plains from a gigantic eruption at Yellowstone, the glacier was gone and the climate had started to warm again. But by then the damage had been done. Nebraska's grasslands and woodlands would never again support the diversity of wildlife we find preserved in the great sheet of Pliocene gravel that stretches from border to border across the state.

This gopher tortoise (*Gopherus oelrichi*) died in its burrow 3 million years ago. It was found north of Ainsworth by paleontologist Morris Skinner a few months before his death in 1989. Nebraska is too cold for such large cold-blooded land animals today, but in the middle Pliocene the climate apparently was much warmer.

