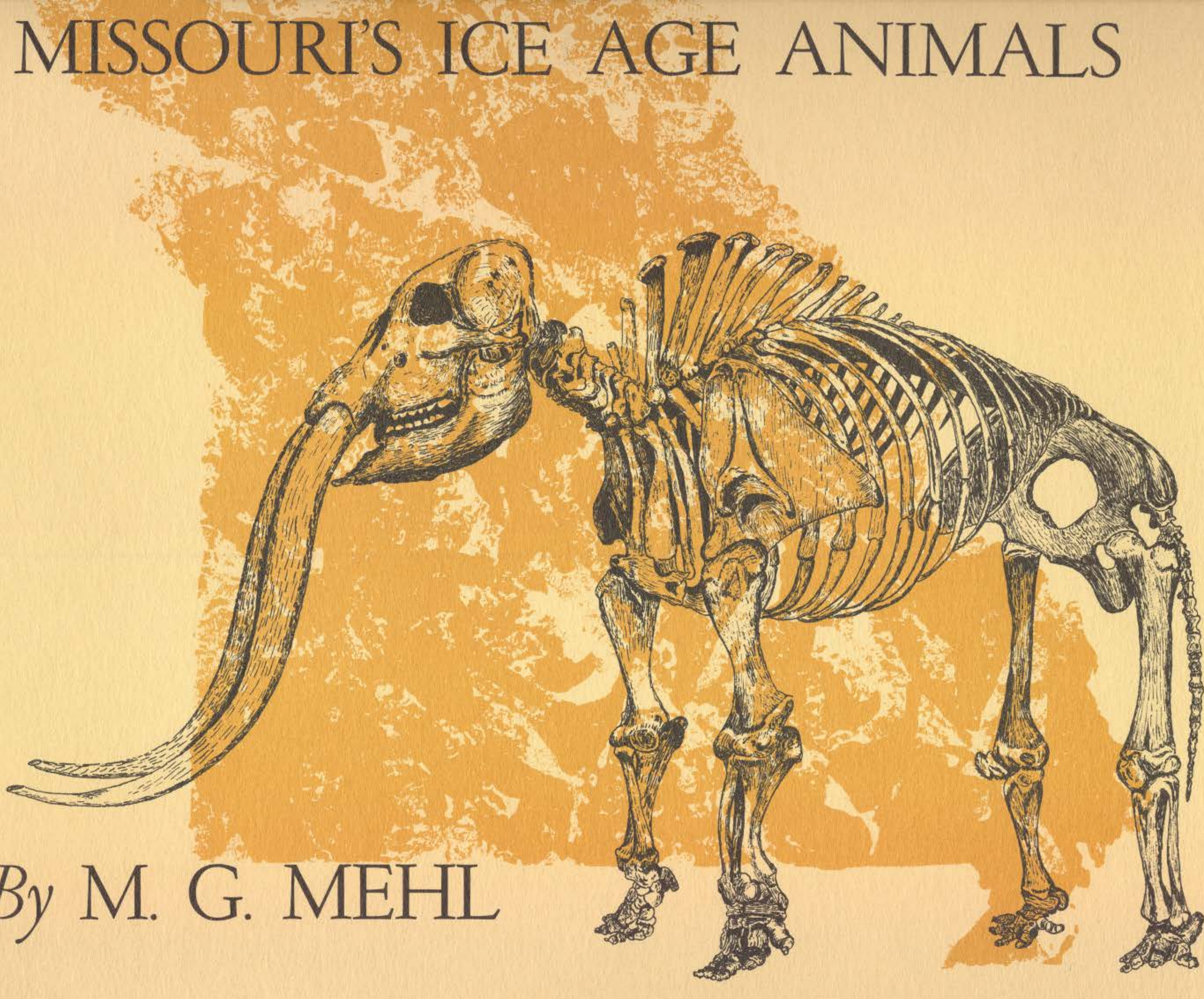
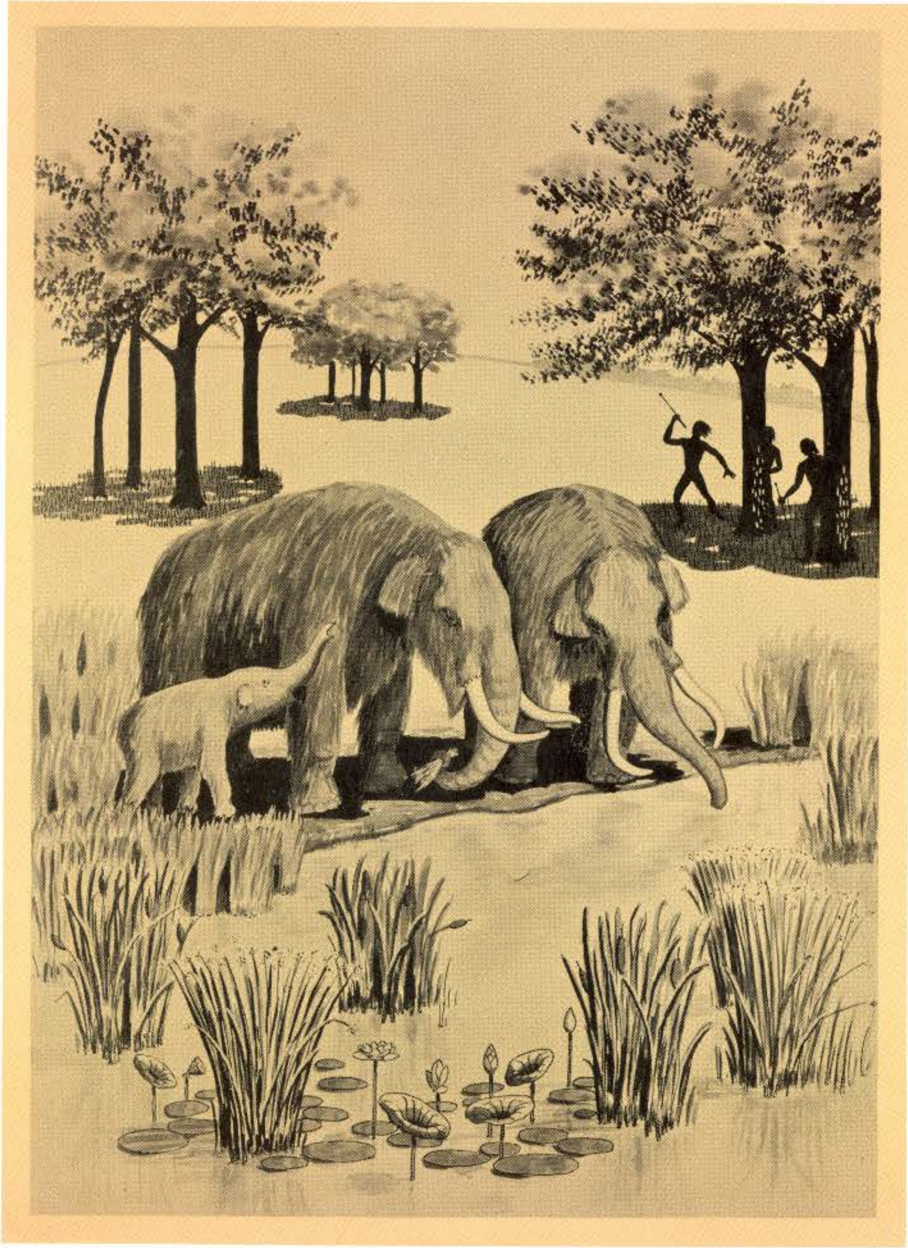
MISSOURI'S ICE AGE ANIMALS



By M. G. MEHL

EDUCATIONAL SERIES NUMBER ONE • STATE OF MISSOURI • DEPARTMENT OF BUSINESS AND ADMINISTRATION
DIVISION OF GEOLOGICAL SURVEY AND WATER RESOURCES • THOMAS R. BEVERIDGE, STATE GEOLOGIST



Frontispiece

Mastodons regarding swamp with stylized vegetation—ancient Indians hoping for the best. Drawn by Eleanor (Mrs. Carl H.) Chapman.

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STATE OF MISSOURI

Department of Business and Administration

Division of

GEOLOGICAL SURVEY AND WATER RESOURCES

THOMAS R. BEVERIDGE, *State Geologist*

Rolla, Missouri

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INTRODUCTION

Missourians have never had an accounting, all their own, concerning the Ice Age and its many strange vertebrate animals that disappeared from the forests and meadows of the state thousands of years before the first white settlers came. In a report prepared by Dr. Oliver P. Hay in 1924 on "The Pleistocene of the Middle Regions of North America and Its Vertebrated Animals", there is to be found, scattered through the pages, all that was then known of the Prehistoric animals in Missouri and other states of the region. Although this report is available in most large libraries, the information is not readily accessible to the average student of nature.

That the public is interested in this early history of the state is evidenced by illustrated news articles that appear with considerable regularity, describing new finds as they are reported by many collectors. So many inquiries concerning "fossil bones" from all over the state have been addressed to the Missouri State Geological Survey at Rolla that the director, Dr. Thomas R. Beveridge, suggested that I compile what information is now available concerning Missouri's Ice Age and its vertebrate animals. The pages that follow record the results of this attempt.

The report is written with the primary objective of answering questions most often asked by the general public. In addition, it is hoped that the specialist will find herein source material that will aid in his studies of those groups of animals and details in which he has a special interest.

ACKNOWLEDGMENTS

In this compilation I am indebted to so many people that it is not feasible to mention all. There is the fisherman who pried a bone from the bank of a stream, the farmer who picked up a tooth exposed in a newly formed gully, the operator of a sand dredge who noticed bones, the man on the bulldozer who plowed into an ancient skeleton, and many others. In an appropriate place, the name of the discoverer of individual finds will be given if it is known. Here, I take the opportunity to acknowledge some of my special indebtedness.

The department of Geology of the University of Missouri has provided laboratory facilities, materials, and personal services. Dr. William H. Elder, Rucker Professor of Zoology, University of Missouri, has made identifications for me. Dr. Carl H. Chapman, Associate Professor of Anthropology, University of Missouri, has called my attention to many finds that have been made in the state and has contributed data for an account of Man and the mastodon in Missouri. The frontispiece is the work of his wife, Mrs. Eleanor Chapman, who has graciously given me permission to publish the picture. Dr. Oscar Hawksley of Central Missouri State College at Warrensburg and his associate, Professor Richard F. Meyers, have found and skillfully excavated numerous specimens in various caverns and have made all of these finds available to me.

The M.S.M. Spelunkers Club at the University of Missouri School of Mines and Metallurgy, under the guidance of Professor James C. Maxwell, has cooperated in many ways. The Middle-Mississippi Valley Grotto of the National Speleological Society in which Gary Schevers and Earl Biffle have been exceptionally active, and the Chouteau Grotto in Columbia, Missouri, under the leadership of George Deike and Jerry Vineyard, have been very helpful. Mr. Donald M. Johnson, Director of the Missouri Resources Museum at Jefferson City, has supplied many data concerning specimens in the Museum. Mr. C. Helmer Turner of Springfield, Missouri, District Geologist for the State Highway Department, has done considerable research on the early finds of mastodons in Missouri and their supposed contemporaneity with Man. His manuscript and notes (1956) have been made available to me, and I have found them of considerable help. Many of the data included in my report are taken directly from the work by Oliver P. Hay, mentioned above.

Dr. Thomas R. Beveridge suggested the project, outlined its scope, and has advised on procedures.

The illustrations, other than photographs, are the work of Mr. Douglas Stark and his assistant Danny Harris. They have converted photographs, rough drawings, and oral suggestions into diagrams and pen drawings which contribute much to the publication.

I am exceptionally indebted to Mr. John W. Koenig who has accepted the task of editing the manuscript. During its preparation, he has made valuable suggestions for arrangement of the materials. He has achieved continuity in places from little more than rough notes.

THE MISSOURI GEOLOGICAL SURVEY'S STAKE IN THE ICE AGE STORY

The Geological Survey and Water Resources Division of the State of Missouri operates under a budget that makes slight provision for basic research as such. However, in the Survey's investigations of more obvious and pressing geological problems, the solution of which have a direct economic justification, there is commonly a by-product—a bonus of information for which ordinarily there is no immediate or evident practical application. The study of the markedly varied deposits of the Ice Age illustrate well one such phase of the Survey's work as is outlined in the following paragraphs.

One of society's more pressing problems is to provide adequate water supplies to keep pace with the many aspects of modern living and with civilization's rapid industrial expansion. Within the short time of a few decades, the water requirement of a few gallons daily per person has increased to more than 100 gallons in most municipalities. The need for increased supplies is particularly acute in the northern half of Missouri, an area that is covered by glacial debris. This area is not so favored with strong springs and spring-fed streams as is the southern part of the state, and ordinary wells and cisterns are often found to be inadequate. Ground water in the bedrock formations of the northern part of the state is too highly mineralized to be potable, especially in the deeply buried formations which contain relatively large amounts of water. Here, people are increasingly dependent on wells that produce from fresh water zones in the deep covering of glacial sands and gravels.

For many years, the Missouri Geological Survey has had a voluntary, cooperative working agreement with the professional well drillers in the state that has resulted in the accumulation of a vast store of information which is on file in the Survey office at Rolla. The drillers make free use of Survey data, and in return they supply the Survey with accurate logs and carefully collected samples from the wells which they drill. From the many records of the wells drilled in the northern half of the state, it has long been evident that the depth to solid rock varies markedly even in adjacent wells. It is also evident that in wells reaching the same depth, there are many cases of great variation in the amount of water available. The accompanying diagram (Fig. 1) gives one explanation for such behavior.

Some years ago, the Survey instituted a test drilling and an instrumental surveying program in northern Missouri with the primary objective of extending its knowledge of the channels of the old stream systems carved in bedrock and subse-

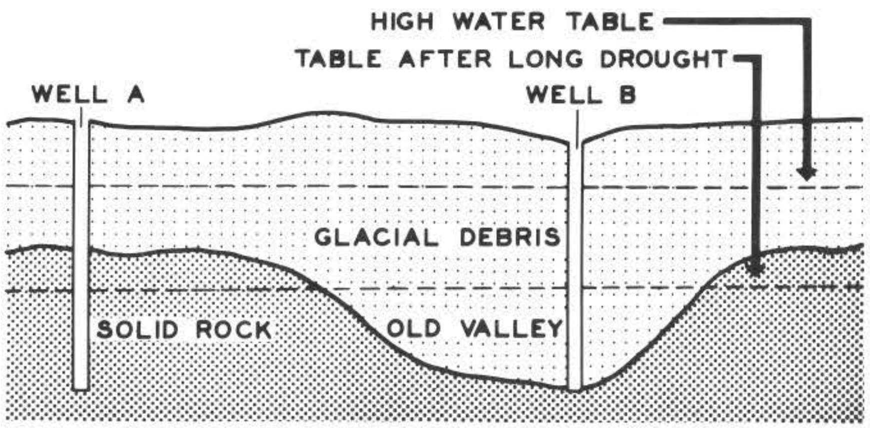


Fig. 1. Wells to the same depth behave differently. When the water table is high, water flows readily into each well through the gravel. When the water table is low the only entrance of ground water into Well A is through cracks and crevices in solid rock, and the water yield may be very low. Entrance to Well B is constant as long as the water table is above the bottom of the well.

quently buried by glacial debris in that area. Some of the major channels, thus outlined, that will contribute greatly to our water supply in northern Missouri are shown in Figure 6.

Not only has the Survey's investigation of the Ice Age deposits provided data on potable groundwater supplies, but the studies have contributed to our economic welfare in many other ways. Limestone suitable for concrete aggregate, road metal, and base material as well as for agricultural lime has been located sufficiently near the surface to permit economical mining. In some areas, the knowledge of the thickness and distribution of Ice Age deposits has eliminated expensive or fruitless search for limestones within the depth zone that would permit economical mining.

In numerous places, clean, well-sorted, sand or gravel deposits have been discovered. One of the larger of these gravel deposits, near La Grange in Lewis County, has produced many thousands of yards of gravel for road metal and concrete aggregate. Unfortunately, the bones that have been found in these gravels have not been recorded adequately.

Within the area of glacial deposits, the markedly varied nature of the materials creates special problems in connection with building foundations. Industrial installations in many of our towns and cities, private residences, or even entire housing areas may experience foundation failure, particularly where "fill" is required. With the information made available by the Missouri Geological Survey, the engineers, architects, and contractors can anticipate and compensate for these difficulties. In some cases, the solution may center around some modification of the subsurface drainage pattern, and in others care with the surface drainage may suffice. Dam sites and reservoir areas must also be carefully planned in areas of glacial deposits to insure that leakage will not be excessive.

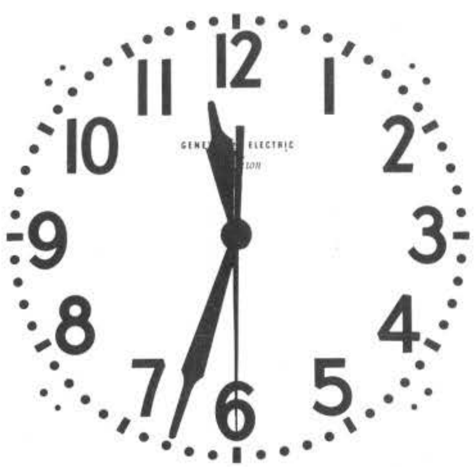
Soil types vary greatly with variations in characteristics of glacial deposits and, thus, knowledge of the geology and distribution of these deposits is necessary for the intelligent mapping and studying of soil types.

In the course of the Geological Survey's studies of the economic aspects of the state's glacial deposits, a considerable record has been acquired of the animals that lived during the Ice Age, along with climatic data and other conditions of the time. It is this information, coupled with the many records furnished by private citizens and previously published data, which forms the background for this report.

GEOLOGY AND TIME

To disassociate events of the Ice Age, or the Pleistocene Epoch as it is technically known, from the history of the earth as a whole is to create a warped and confusing picture of time involved in the earth's story. In the attempt to evaluate particular events, it has been found useful to reduce the entire history of the earth to terms of a 12 hour day as is done in the accompanying diagram (Fig. 2). Here 12:00 o'clock marks the birth of the earth, and the sweep of the hour hand around the dial again to 12:00 marks, not the end, but today. Some details of the methods of determining the age of earth events are outlined in the following paragraphs.

Fig. 2. (Next page) The "Geological Clock". The age of the earth is represented by the 12 hours on the face of the clock. The sweep of the minute hand around the dial twelve times from 12 to 12 marks the passage of time from the beginning of the earth to today.



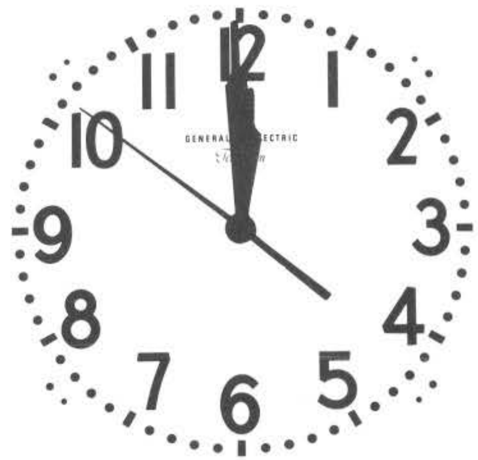
At about 4.48, not far from half the earth's age, life first appeared. This is not to be classified as either plant or animal life because it possesses the simple properties of each. One is less likely to speculate enthusiastically about the possibilities of human beings on other planets when he contemplates the vast amount of time required to marshall all of the many and varied factors involved in the simple beginning. He realizes that the likelihood of duplicating the earth's multitudes of environments, in the same order and intensity, on other planets is remote.

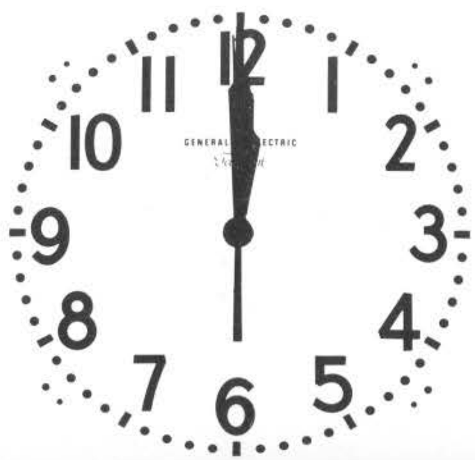
At about 10:45 plus 6 seconds, nearly all of the great groups (phyla) of animals were represented by at least a few forms. Even simple vertebrates were probably present although they left no known fossils. For the most part it was only forms that had shells or other hard parts that had a chance to be preserved. When one considers the many forms that today have no hard parts, he realizes that fossils alone give a far from complete picture of the past. At about 11:33 plus 30 seconds, the Reptiles started to rule the earth and continued to dominate until the Mammals took over. This was the time of the Dinosaurs—large and small, the Pleisosaurs, Ichthyosaurs, Mosasuars, and Pterodactyls. The Turtles, Crocodiles, Snakes, and Lizards were present too but were in the background. This was truly the "Age of Reptiles."

At about 11:51 plus 22 seconds, the great ruling races of Reptiles had disappeared, and the Mammals took over the domination of all environments. Quickly, the big, clumsy Mammals took the lead, mostly forest dwellers. The modern kinds gradually replaced them as the plains' grasses developed and the forests shrank.

The Pleistocene Epoch started at about 11:59 plus 51 seconds, just 9 seconds ago. There was no evidence of Man in North America this early. Most of the animals found in Missouri today were here then, including Horses. All of the Horses disappeared from North America before the first men came, although most of the history of this group was written in the rocks of this continent.

Man appeared in North America at about 11:59 plus 59 6/7 seconds, just 1/7 second ago! The climate, plants, and aimals were then much the same as today. It is likely that some Mastodons and possibly Elephants, Sloths, and Peccaries were still to be seen. In Europe Man had appeared earlier.





From the beginning of the systematic study of the earth's history, it has been evident that our planet is very old, but early attempts to fix its age were far from satisfactory. It was found that all of the several different approaches to precise age determination of earth events involved so many variable factors that any estimate was little better than an intelligent guess. However, comparatively recently, the determination of the lead-uranium ratio in igneous (once molten) rocks has been so perfected that the date of events in the very distant past can be stated with great confidence. In uranium bearing rocks, the uranium disintegrates very slowly and at a rate that follows a definite and invariable formula. The product of this disintegration is lead and helium, and the ratio of these two elements is the key to the age—the larger the lead-uranium fraction the more ancient the rock.

The oldest rock available for *direct* examination today is known to be about 3,500,000,000 years old. This does not mean that this figure represents the age of the earth. The time of its birth, judged from the age of some meteorites that are believed to have been a part of this event, is close to 5,000,000,000 years ago.

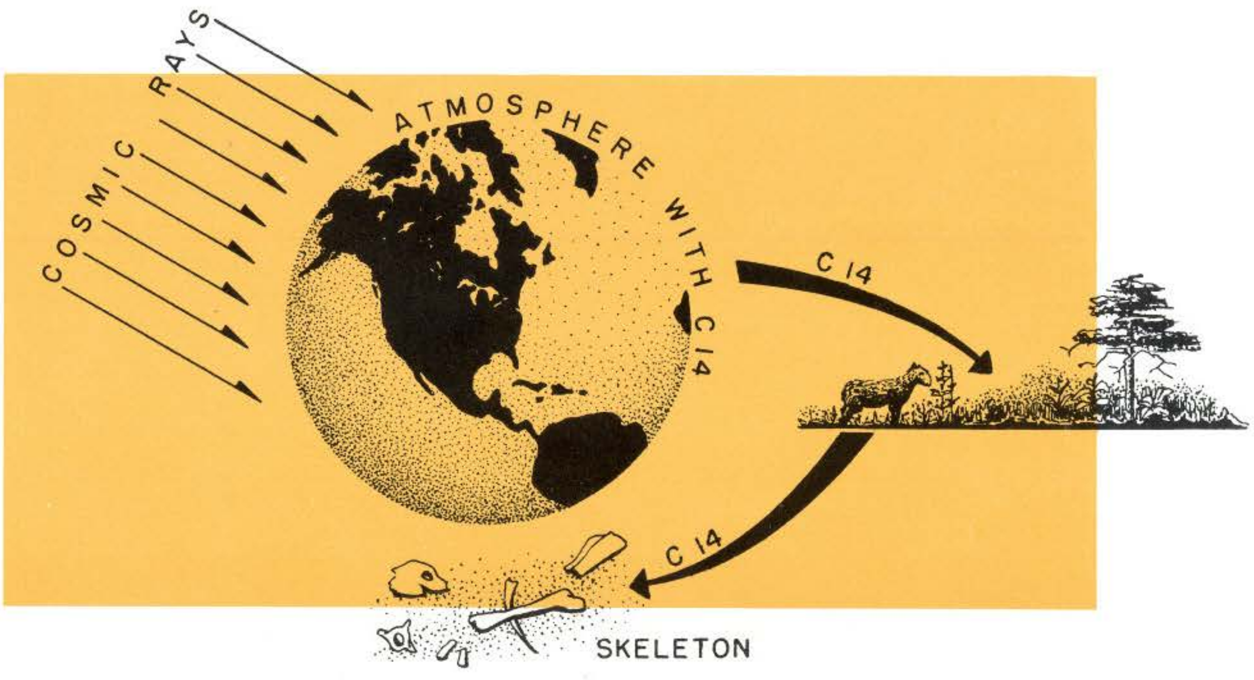
There is another method of estimating geological dates very accurately for events that are relatively recent. This is the Carbon-14 or "half-life" method which involves the rate of disintegration of Carbon-14. In this material the rate of disintegration is much more rapid than that of uranium and, therefore, the results are of little value beyond about 50,000 years.

All plants take in carbon dioxide, and in doing so they accumulate minute quantities of Carbon-14 which is the name for a radioactive carbon. It follows that all living things (plant or animal) contain some Carbon-14 because animals are dependent, directly or indirectly, on vegetation for food. Upon the death of the organism, the radioactive carbon begins to decay at a constant rate. Half is lost in the first 5,568 years,* half of the remainder in the next 5,568 years, and so on for the life of the element if left undisturbed. Comparison of the amount in the dead organism with that in the living form fixes the age very accurately. Of course, the amount of Carbon-14 that remains in an organism long dead may be so small that the proportion is difficult to determine. For events as recent as 10,000 to 15,000 years, the time can be pinpointed with considerable accuracy. Vegetation, bones, teeth, ancient fabrics, and similar items lend themselves well to this method.

Elsewhere in this paper, under the general heading "Suggestions to Collectors," the reader will find a description of a rapid "do-it-yourself" way to find a clue to the age of bones and teeth.

*These figures have been modified slightly in recent publications.

Fig. 3. (Opposite page) Radioactive carbon, C14, becomes part of bone composition. Carbon-14 from the atmosphere becomes part of plants and is transferred directly to vegetation feeders and indirectly to flesh eaters.


COSMIC RAYS
ATMOSPHERE WITH C 14
C 14
C 14
SKELETON

Classifying Geologic Events

A conventional earth event chart with the time estimates for each major division of geologic time is shown in Figure 4. This chart shows that just as events in human history are grouped together and arranged in categories such as ancient, medieval, or modern, the events of earth history are also grouped according to time and relationships. In both kinds of history, the volumes are made up of chapters, and these are divided into major and lesser subdivisions. The volumes of earth history are called *eras*, of which there are five. The chapters of each volume of earth history are called *periods*, and major subdivisions of periods are called *epochs*.

Similar to the volumes of human history, the volumes of earth history are not of the same size but vary from large to comparatively small; for each is the complete story of a major subdivision of the record. It is the same with the chapters that make up the earth history volume; some chapters are short by comparison and others are very long. The number of chapters in each volume of earth history also varies, depending on the story that is told. A study of the accompanying simplified time chart will show how the Ice Age or Pleistocene Epoch fits into the geologist's scheme for classifying events of the earth's history.

The Pleistocene Period—or merely Pleistocene as it is conveniently referred to by most geologists—is defined as starting with the last (ignoring fluctuations) extensive spread of continental ice in the northern hemisphere. Some authorities consider that this epoch, the last to be named, continues today. The events which have taken place since the ice retreated to near its present boundaries are commonly designated as "Recent"; they are the events of the recent division of the Pleistocene Epoch.

ERAS	PERIODS	EVENTS	LIFE
CENOZOIC (60 m.y.)	Neogene (28 m.y.)	Glaciation	Rise of man. Extinction of primitive types of mammals. Development of modern kinds of mammals.
	Paleogene (32 m.y.)	Rocky Mts. and other Western mountains Great lava flows	Appearance of primitive man. Modern plants throughout the Cenozoic. Appearance of modern species of mollusks. Beginning of modern types of mammals.
MESOZOIC (125 m.y.)	Cretaceous	Rocky Mts.	Culmination of reptiles. Culmination of complex sutured cephalopods in America. Great abundance of clams, particularly of the oyster type. Appearance of flowering plants.
	Jurassic	Sierra Nevada Mts.	Great development of many kinds of reptiles. First appearance of birds. Mammals small and rare. Culmination of complex sutured cephalopods in Europe.
	Triassic	Aridity Volcanism	Appearance of dinosaurs, flying reptiles, swimming reptiles, and mammals. Rise of complex sutured cephalopods.
PALEOZOIC (335 m.y.)	Permian	Glaciation Appalachian Mts. Aridity	Development of many kinds of strange reptiles. Disappearance of trilobites. Great reduction in life in the later part of the period.
	Pennsylvanian		The first reptiles and insects. Culmination of Paleozoic plants.
	Mississippian		Great development of sharks and crinoids. Plants become abundant.
	Devonian		Development of fishes with rise of all main groups of fishes. Development of paired limbs. First forests. First amphibians. Old-age characteristics in trilobites.
	Silurian	Aridity	Appearance of scorpions, air breathers. Fishes rare. Crinoids important. First coral reefs.
	Ordovician	Taconic Mts.	Rise of cephalopods. Appearance of fishes.
	Cambrian		Trilobites and brachiopods dominant. First abundant fossils.
ALGONKIAN (1500 m.y.)		Glaciation Volcanism	Some fossils, but all poorly preserved and most of them nondeterminable. Algae, the most common form of life.
ARCHEAN (3000 m.y.)		Volcanism	Fossils? Some indications of life.

Fig. 4. Geological time-event chart. Modified from Branson and Tarr.

THE "GREAT ICE AGE" OR PLEISTOCENE EPOCH

To the average Missourian, the "Great Ice Age" means "a time—long ago—when the earth was very cold, and the northern half of Missouri was covered by a thick blanket of ice." He is inclined to think of this as a tragic event when many strange animals, like elephants, camels, sloths, tapirs, and wild pigs, were faced with shrinking food supplies; a time when it was common for large groups of these animals to be trapped in the drifting snow so that ultimately entire races disappeared.

Although the geologist uses a different terminology, he knows what the interested observer means when he speaks of the Ice Age, and the two agree on many of its major features. Both know, for instance, that Missouri *was* once covered by ice as far south as the Missouri River. The two may not agree about the climate and the details concerning the animals of that time, but they do agree that the event, regardless of how long ago, has influenced our affairs, even today! They know that irregular land surfaces to the north of the river were completely obscured by the relatively thick mantle of glacially transported rock waste (drift) that was left when the ice finally melted from Missouri. They see the differences in the land surface (topography) to the north of the river and that to the south. They realize that the glacial debris, together with the mantle of silt and fine rock dust (loess) picked up along the streams issuing from the melting ice and deposited by ancient dust storms, have much to do with the marked differences in the soils of various parts of the state. They can see the connection between glaciation and the problems of water supplies, the availability of gravel deposits and quarry sites, the problems of highway building, and many aspects of agriculture. It is because of some of the details about which the two may *disagree* that a designation other than the Ice Age is desirable—a terminology that is better fitted to describe the events of the time as they apply to all states, and to other countries as well. The geologists throughout the world call this time the Pleistocene (Greek: *pleistos* most + *kainos* new.) Epoch.

The student of geology recognizes that if we define an ice age as any marked spread of the great ice caps beyond their present-day limits, "Ice Ages" were not uncommon in the long history of our earth. He knows also that the advance of the ice into northern Missouri was really a two-fold event; a first advance followed by a complete melting away, and a second more widespread advance. He knows that in other states the ice invasion consisted of as many as four distinct advances and retreats, and that in still other areas there was no ice covering at all. However, time and events were going on in all these places, regardless of the behavior of the ice, and the geologist must have a name for the geologic time that will apply equally well in every place.

Cause of the Ice Age

Everybody has noticed that within a few days after snow has fallen in feathery flakes, there is a change in the accumulation toward granular ice. These granules are commonly cemented into solid ice by freezing water derived from the upper melting surface. This packing and cementing of tiny ice spherules derived from snow is the way in which glacial ice is formed.

The immediate cause of any ice age is evident—an excess of snowfall over wastage (either through evaporation or melting) in the area where the glacier originates. Ordinarily, we think of low temperature as of prime importance in this excess over melting in any area, and we expect glaciers to occur at high altitudes or in high latitudes. However, without a supply of moisture for snowfall, there could be no glacial ice, regardless of the temperature of the region.

So far as North America is concerned, it is known that the continental glaciers of the Pleistocene spread from three major accumulations of ice as indicated in the accompanying map

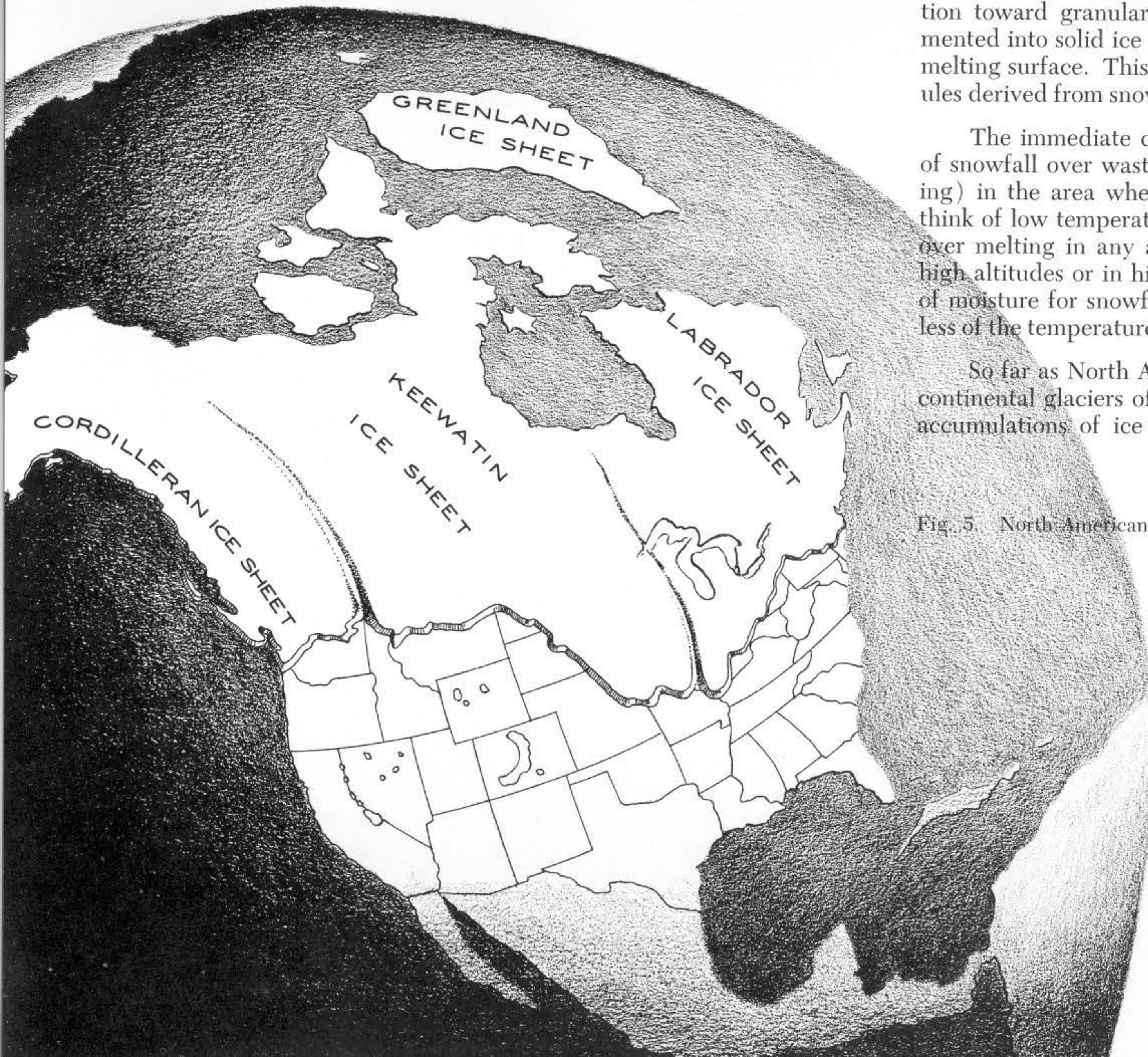


Fig. 5. North American centers of Pleistocene glaciation.

(Fig. 5). It is also known that at these centers of accumulation the land was high, but the elevation alone does not appear to have been sufficient to account for the ice accumulation. Elevation alone seems entirely inadequate when one considers the complications imposed by the succession of advances and retreats of the margin of the ice caps.

A favorite speculation of the many offered to explain Pleistocene glaciation suggests "wandering poles". In other words, the idea is considered that the North and South Poles have occupied positions other than that of today. The mechanical difficulties involved in such rhythmic shifting are evident, and few geologists give the theory serious consideration.

Perhaps the most important single factor of the many that were involved in the origin of the great ice sheets is an exceptional atmospheric behavior that tended toward permanent lows of barometric pressure in certain areas. This condition, coupled with exceptional supplies of moisture, might well account for all the complexities of ice movement. In this connection, it is interesting to speculate on what changes we would see in Missouri's landscape if, for a very long time, the area were supplied with sufficient moisture to permit snowfall at fullest capacity every hour of the year when the temperature was sufficiently low. There can be little doubt that there would be startling changes, although neither the mean annual average temperature nor the elevation of Missouri would have to be changed.

How the Ice Moved

Ice is not strong and unless confined cannot support nearly as much weight as does ordinary rock—even weak rock like shale. It follows that where a great thickness of ice is built up on a land surface, the ice tends to settle because of its own weight, and its margin spreads laterally in the direction of least resistance. The fact that the glacial ice was formed from snow which was regularly converted into spherical granules, packed, and cemented together, probably is an important factor in the conspicuous "flow" of the ice. Our great ice invasions were not caused by a thick sheet of ice that slid downhill from the north, but rather by the slow spreading outward of the ice much as molasses spreads when poured out-of-doors on a flat surface in January.

Details of Missouri's Ice Invasion

During the first glacial invasion of Missouri, or the Nebraskan Stage as it is technically known, the southern margin of the ice reached an arc somewhat short of the present Missouri River course. In general, the ice terminus was in the region of Ralls, Monroe, Randolph, Chariton, Carroll, Clinton, and Buchanan Counties (Fig. 6). The time was probably close to a million years ago. Although this margin was nearly stationary for many thousands of years, it must be remembered that there was continued forward movement of the ice, and the position of the margin was the place where the melting balanced the forward movement.

After perhaps as long as 50,000 years, the melting became greater than the forward movement, and gradually the ice retreated from Missouri. The deposits of the Nebraskan Stage that were left exposed in Missouri presented an irregular, poorly drained surface. The normal processes of rock rotting or weathering continued to attack the upper surface of these deposits for 75,000 years or more, and a mantle of "soil" (gumbotil), averaging about 5 feet in depth, was formed.

A second ice invasion, the Kansan Stage, overrode the gumbotil and covered northern Missouri to reach approximately the present Missouri River course. The duration of this second

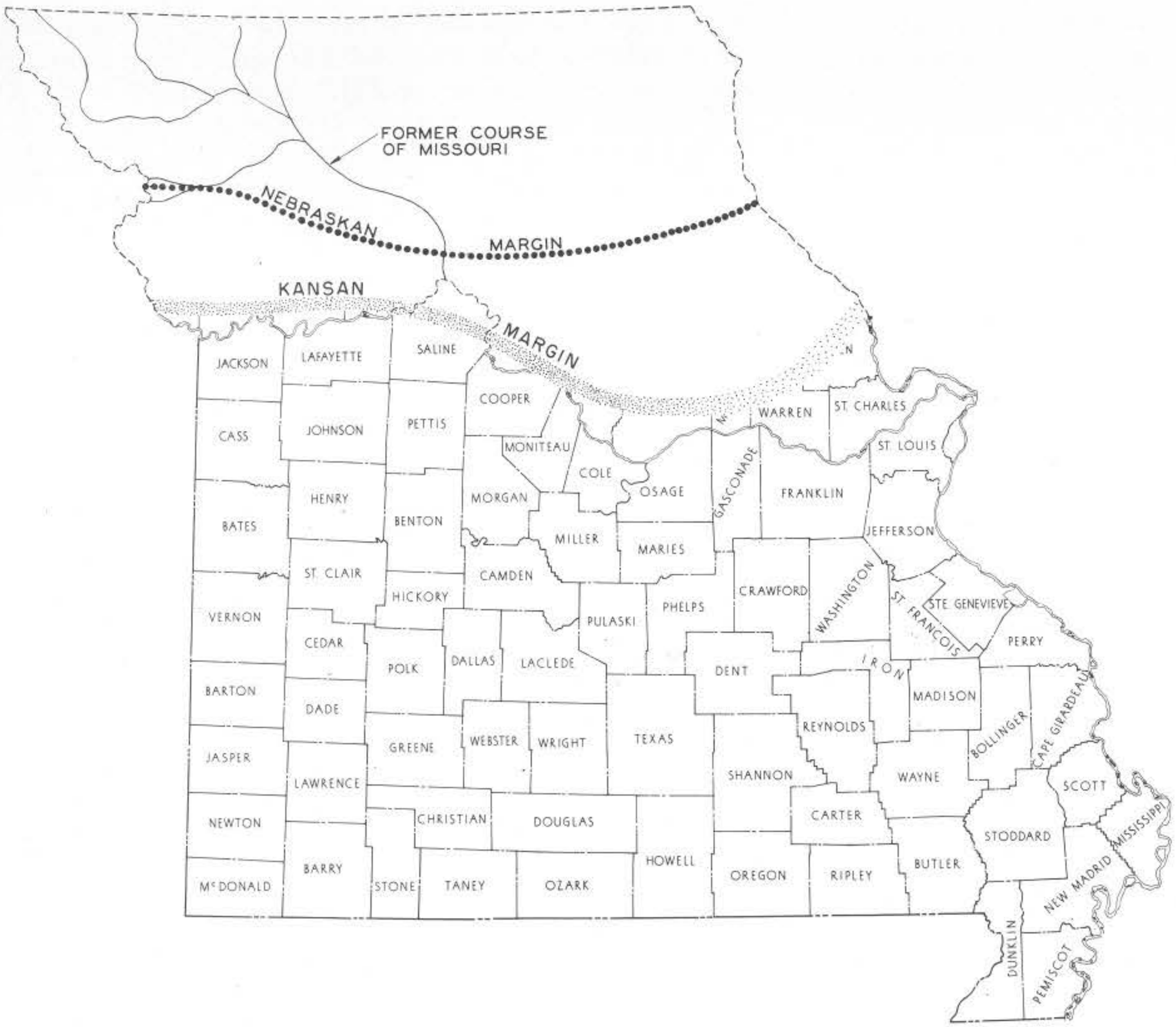


Fig. 6. Approximate maximum extent of Nebraskan and Kansan ice sheets in Missouri. Some major features of preglacial drainage in northwestern Missouri are indicated.

invasion is speculative but probably somewhat longer than the first.

For completeness of the record, it should be mentioned that a third spread, the Illinoian, may have invaded the extreme eastern edge of Missouri when, with the movement south and westward in Illinois, the ice crowded the Mississippi River westward from part of its course which is now occupied by the Kaskaskia River of Illinois. Glacial deposits, presumably from this stage, are found in the river bluff north of Ste. Genevieve, and ice-carried boulders are found on some of the high points near the bluff to the south of this point and also farther to the north.

From the time of the last retreat of ice beyond the northern boundary of Missouri, the glacial debris left behind has been weathered to considerable depth, except in those places where it has been fairly well protected by a mantle of wind-carried rock dust (loess). The time subsequent to the retreat of the last ice sheet, which did not enter Missouri, to near its present position is spoken of as "Recent" regardless of the fact that the retreat was probably accomplished more than 20,000 years ago.

The Nature of Glacial Deposits

When geologists first recognized the presence of parallel scratches (striae) on bed rock and overlying heterogeneous deposits of clay, sand, cobbles, and boulders, some of which are of great size, they interpreted these features very differently than is done today. The early workers recognized that some exceptional carrying agent must have transported the great boulders and that the agent was also exceptional in that the large boulders were commonly found in the midst of comparatively fine material. But it did not occur to them that the northern part of our country had been covered by great ice sheets.

The coarse and fine materials which they saw grouped together was conceived of as being the result of ice rafting—icebergs that floated southward during the "Noachian flood" to melt and dump their load in a shallow sea. The striae on bedrock, they thought, were the result of rock-studded icebergs touching the bottom in shallow parts of the water. It was logical, with this interpretation, that they should call the deposits *drift*—as they did. It was many years after Agassiz's* analysis of glaciation in 1837 that scientists were convinced that some of our present day glaciers once invaded vast areas of land beyond their current margins.

GLACIAL DRIFT.—The old term *drift* is used today, but its meaning has been changed and is now fairly well standardized. Conventionally, the newer meaning is safeguarded by adding the qualifying word *glacial*. In reading the reports of the earlier Missouri geologists, one must recognize that their use of the term did not distinguish between ordinary stream gravels or the obviously residual material resulting from the weathering of bedrock and those materials that resulted from glacial transportation and deposition. Glacial drift, as commonly used today, includes not only glacial carried and deposited material, but material that was rearranged by melt waters from the glacier—*glaciofluvial* deposits—which may show some degree of sorting. The part of the drift that includes only the glacial transported material, dumped without sorting, is *glacial till* or simply *till*.

TILL.—One cannot expect the general reader to become thoroughly conversant with all aspects of glacial deposits through the perusal of a few pages on the subject. However, if he keeps in mind the manner in which the ice is shoved for-

*Louis Agassiz, a Swiss naturalist (1807-1873) who was Professor of Natural History at Harvard University from 1848 to 1873.

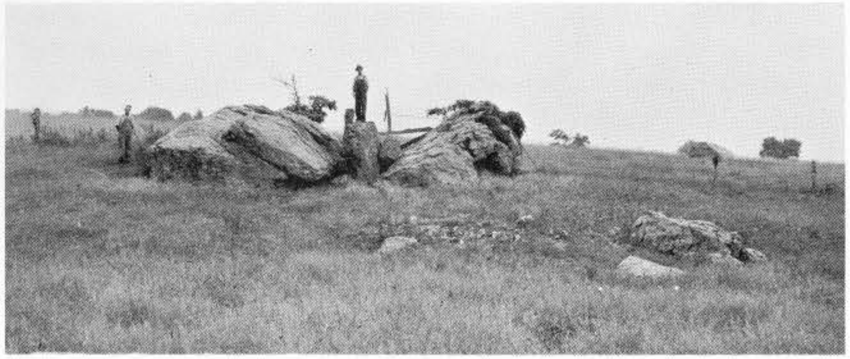
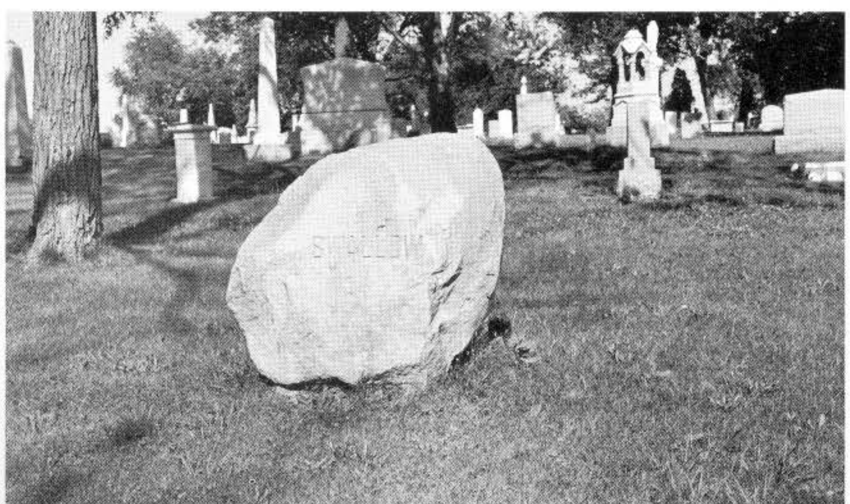


Fig. 7. Large erratic (glacial carried boulder), one of the largest in Missouri. The boulder is situated northwest of Monroe City on the farm of Mr. S. A. Oliver, Jr. The several large granitic pieces were carried as a single unit which was subsequently cracked and distributed by natural forces.

Fig. 8. A granitic erratic about 5 feet high in a Columbia Cemetery marks the grave of George C. Swallow (1817-1899) first professor of geology at the University of Missouri.



ward and how it may wear rigidly-clasped boulders as they are scraped across resisting rock surfaces, he can anticipate most of the features that are characteristic of *till* as they are outlined below.

The ice carries the largest and smallest rock units together just as soil and concrete slabs may be carried in the same truck load. Just like unloading the dump truck, the ice leaves much of its heterogeneous load in one spot when the ice melts. Thus, the deposit consists of a mixture of different sized elements which are not at all bedded. 'Bedding in water-laid sediments is largely the result of sorting according to size.

ERRATICS (foreigners).—Erratics are rocks that are carried from one drainage basin into another. Boulders derived from rocks that crop out in one drainage basin cannot get into another except by a transporting agent that can carry them up a slope and across the divide or divides into another basin. Rocks most easily recognized as erratics in glacial till of northern Missouri are of igneous origin, because there are no outcrops of igneous rocks in Missouri north of the Missouri River. A very common erratic in Missouri till is a hard, reddish-pink quartzite that was derived from outcrops near Baraboo, Wisconsin, (the Baraboo quartzite). Native copper from the upper Great Lakes area and small amounts of gold which may have come from Canada are known to occur in the glacial drift of Missouri.

FACETED AND STRIATED BOULDERS.—As the rock-shod ice is shoved across bedrock, flat faces (facets) with parallel striae may be ground on individual cobbles or boulders. It is the resulting scratches on bedrock that are the best indication of the direction of ice flow.

GUMBOTIL.—When the ice retreated leaving behind a mantle of till, the normal processes of rock decay began to mod-

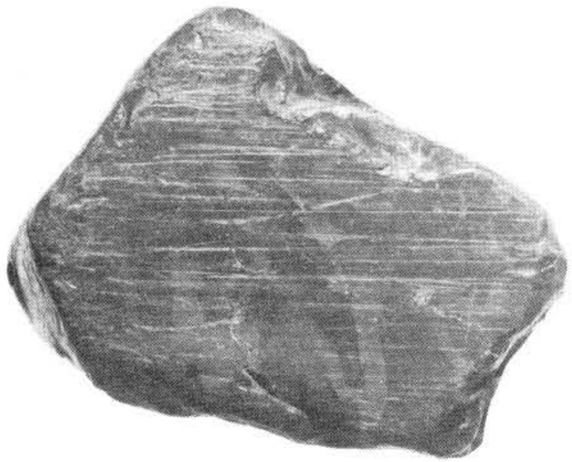


Fig. 9. Glacial worn cobble. This igenious rock, about 10 inches long, faceted and striated, was found in the glacial till near Columbia, Missouri.

ify the materials of the till's upper part. After thousands of years, all but the almost insoluble boulders and pebbles, like quartz, chert, and quartzite, were reduced to a gumbolike mass called *gumbotil* (gumbo derived from till).

GLACIOFLUVIAL DEPOSITS.—Associated with many till deposits are lenses and filled channels of fairly well sorted sand and gravel. Melt-waters descending through crevices in the ice may be organized into crude stream systems that, like ordinary rivers, sort and distribute much material according to size. These glaciofluvial deposits were conspicuous under the ice, at its margin, and beyond.

LOESS DEPOSITS.—In the earliest reports of the Missouri Geological Survey, various writers used the term *bluff* or *bluff deposit* to describe a thick mantle of fertile soil in the northern part of the state that is thickest near and stands in vertical faces on the bluffs of the major streams. This material, with its distinctive characteristics, is the *loess* of today. The word is of German origin (Löss) and is difficult for the average American to pronounce. In addition to its German pronunciation, it has been pronounced *lurse, less, lō'ess*, and *luss*. The latter is perhaps the most commonly used.

Strictly speaking, loess is any deposit of wind-carried, rock fragments; excepting only materials derived from volcanic explosions. So far as the loess of Missouri is concerned, its chief source was the fine rock powder produced by the grinding effect of the glaciers. The waters issuing from the margin of the ice spread this rock waste on the flood plains where it quickly dried and was picked up by the wind to be spread as an all-covering blanket over the land surface. Recognizing this as a much simplified account of loess origin, it is sufficient for an understanding of the features that characterize the deposits.

The color of loess consists of a variety of shades of buff—with some, the color is better described as gray. Loess consists of very fine particles of rock, most of which are splintery or angular. Being a wind carried deposit, it follows that there are no coarse particles in loess, excepting, of course, some small or large nodules that are formed at a later time.

Loess makes rich soil because many of the powdered original rock minerals have not been greatly altered. It stands in vertical walls when cut by roads or streams because of its sharp interlocking particles and because descending waters have carried mineral matter downward to act as a cement. Loess is thickest near the bluffs of the larger streams because it settles thickest near its point of capture by the wind. Especially thick deposits are developed in northwestern Missouri along the east side of the Missouri River.

In many places, irregular shaped nodules of calcium carbonate, called *loess kindchen* (German terms meaning *loess babies*) may be found. These nodules are formed when calcium carbonate is dissolved at or near the upper surface of the loess and is precipitated lower down about some fragment, possibly a skull or some bones of a gopher, such as has been recorded elsewhere in this article at locality MGSQV-1088 in Holt County.

A fine summary of information on Missouri till sheets, gumbotil, and loess deposits is given in a publication prepared by Dr. E. B. Branson[*] in 1944 (*The Geology of Missouri,* University of Missouri Studies, vol. 19, no. 3). The glacial report included in this publication was furnished by Dr. C. D. Holmes[†] on pages 337-345.

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*Edwin B. Branson (1877-1950) was Professor of Geology at the University of Missouri from 1910 to 1950.

†Chauncey D. Holmes (1897-   ) has been Professor of Geology at the University of Missouri since 1949.

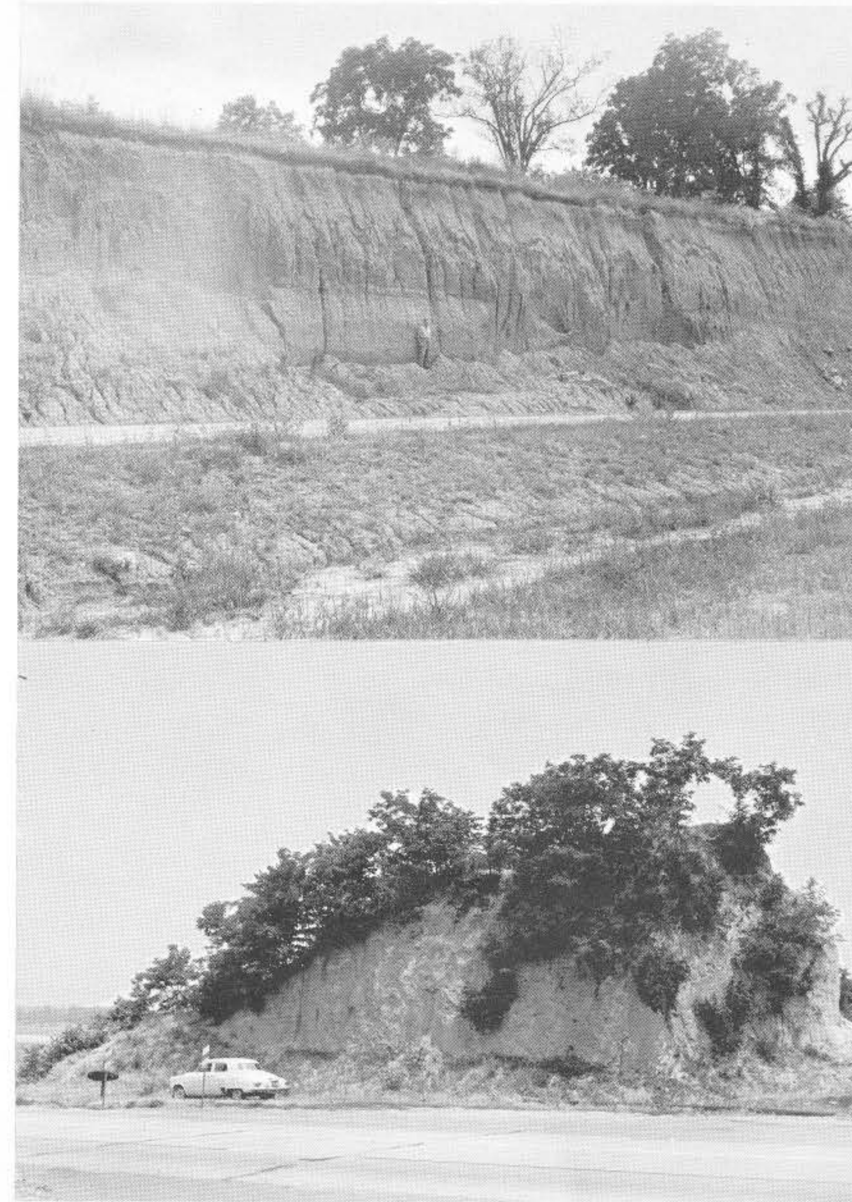


Fig. 10. Loess deposits. Cuts on U.S. Interstate Highway 70: (above) near the bridge across the Missouri River in Boone County; (below) near Missouri River bridge in St. Louis County.

Missouri During the Ice Age

CLIMATE.—It should be remembered that Missouri was ice-invaded for a much shorter time than it was ice-free during the Pleistocene. What is known of the vegetation during the ice-free time indicates temperatures comparable to those of the Missouri of today or a climate even more mild. There have been identified in vegetable accumulation between two ice invasions near Toronto, Canada, plants that occur ordinarily only much farther south. During the glacial invasions, the ice was not formed by low temperatures and precipitation in Missouri but by conditions far to the north. In Missouri, the ice was melted as rapidly as it moved forward, and it is quite possible that the mean average annual temperature was little, if any, lower than today. It seems probable that extremes of temperature during the year were less pronounced than now.

VEGETATION AND ANIMALS.—It may not be long before glaciologists will give us a very accurate picture of the vegetation that grew in Missouri during the Pleistocene, including times of ice invasion. Dr. C. D. Holmes, of the University of Missouri, and others are engaged in the study of plant spores and pollen in the glacial and interglacial deposits of the state and are making considerable progress in reconstructing the vegetation picture. In the meantime, the animal record of the Pleistocene provides some pointed suggestions. The vegetation eating groups of mammals (herbivores) include great herds of strictly grazing forms and an equally large number of browsing forms, as will be explained in later paragraphs. The grazers, such as the horses, could not have thrived as they did without a constant supply of nourishing grass. The browsers, like the mastodons, required coarse shrubbery that did not "winter kill".

FOSSILS

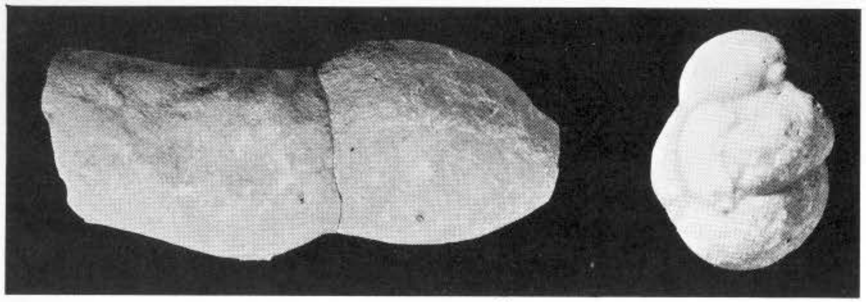
Of the many animals that lived in Missouri during the Pleistocene Epoch, only finds of the vertebrate (back-boned forms) will be listed. This list omits the remains of invertebrate animals, such as clams, snails, and insects, as well as the particular kinds of plants. Among the vertebrate remains, only those finds that are thought to be fossils will be included.

What is a fossil?—For the interpretation of the data of this publication, let us agree that we will consider a fossil to be "any direct evidence of an organism that lived before the Recent Stage of the Pleistocene". This means that the manner in which the object is preserved is of no importance; it is the time element that counts. Some of the bones differ little in their preservation from those that are only a few years old, and others are markedly changed by decay or by mineralization (petrification). One can speak of finding a fossil bone or plant, whether it is an impression of, or the original object. But to speak of a "fossilized bone" implies a special kind of preservation, and our definition does not include this. Commonly, "fossilized" seems to imply "petrified" or impregnated with mineral matter, and most of the Pleistocene fossils are not so preserved. The frozen flesh of the mammoth found in Siberia, described later under the discussion of the mammoths, is a fossil according to our definition.

Pseudofossils

In any discussion of fossils, reference should be made to the many objects which, in their general shape, resemble the finder's concept of how some ancient organism may have appeared.

Water charged with dissolved mineral matter is likely to



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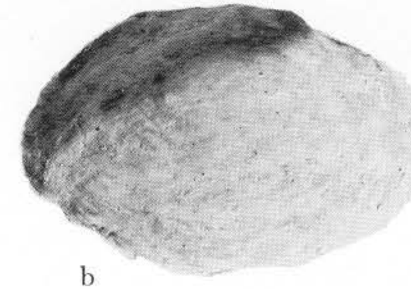

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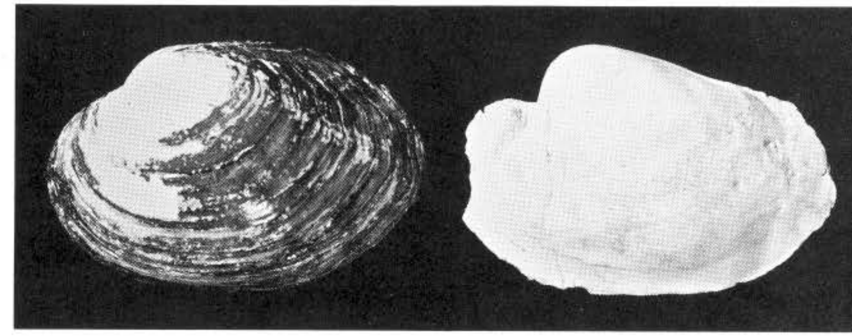

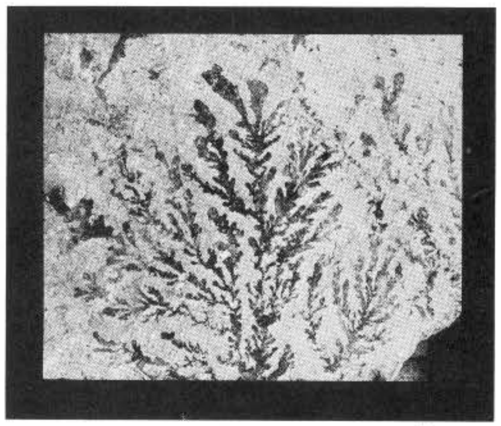

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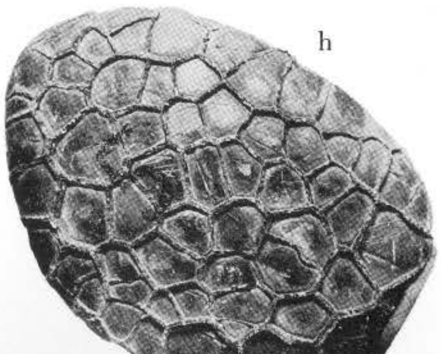

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Fig. 11. Fossils and pseudofossils. (b, c, and d) show external mold, cast, and internal mold of a modern clam (a); (e, f, g, h, and i) are pseudofossils—(e and f) two specimens of loess kindchen, (g) manganese growth, (h) a septarian (the latter was reported as a "fossil turtle"), and (i) mold of "sun-cracked" mud surface; (j, k, l, m, n, o, p, q, r, s, t, and u are fossils—(j) internal mold of a Pennsylvania plant *(Calamites)*, (k) fossil wood with knot, (l) carapace of a Pleistocene turtle, (m) footprint of a Triassic dinosaur, (n) *Taonurus caudagalli,* (o) skull of an Ichthyosaur; (p) shows the tooth marks of a gnawing animal on the leg bone of a deer. It is possible that both lived during the Ice Age. (q) Devonian brachiopod, (r) Cretaceous leaf, (s) central column of a bryozoan *(Archimedes)*, (t) impression of a Mississippian marine plant frond, and cast of the attachment bulb of the same; (u) large coral colony.

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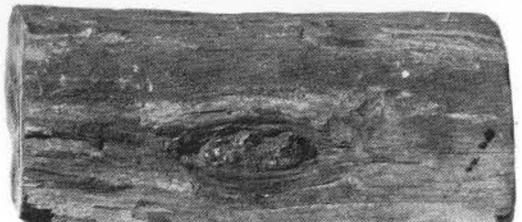

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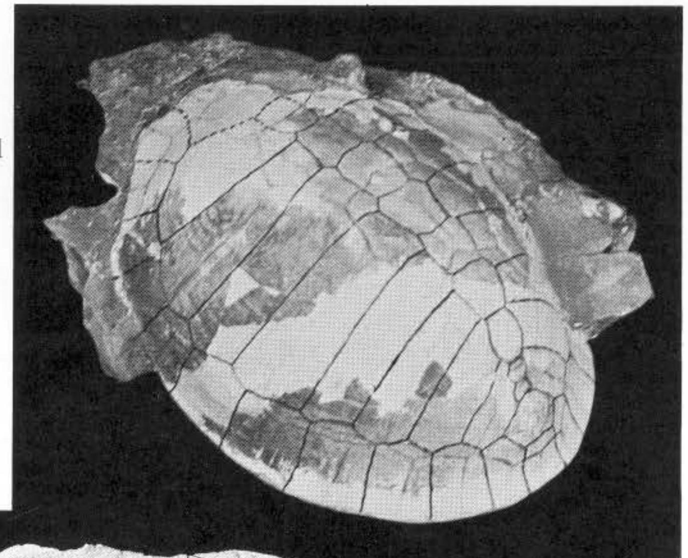

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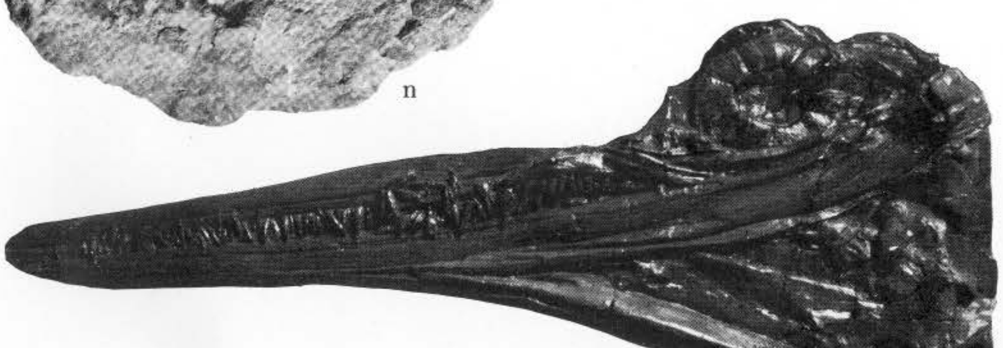

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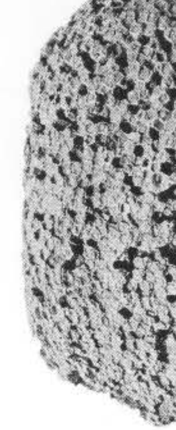

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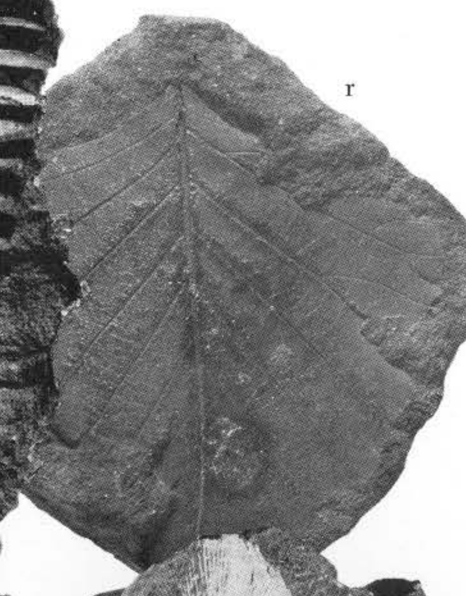

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precipitate some of its load in irregular or symmetrical forms called *nodules* or *concretions*. A concretion is commonly the accumulation of mineral matter about some object like a tiny plant fragment, a scrap of bone, or a small shell. The concretion may "grow" to assume many imaginable forms. It is not surprising that nonspecialists sometimes think they have found the bone of some strange animal only to find that it is a peculiarly shaped rock. One of the most common mistakes is to identify some irregularity on the surface of a rock as the footprint of some animal. Markings on the surface of ancient limestone, formed at the bottom of relatively deep water, have been mistaken for human footprints. The accompanying illustration (Fig. 11) shows real fossils and a variety of pseudofossils.

Another category of mistakes might be spoken of as "misplaced identities"—remains that are fossils but are commonly mistaken for objects of an entirely different nature. A massive colony of fossil coral may be called a "petrified honeycomb", or the spiral axis of a fenestrate bryozoan may be mistaken for the vertebral column of a fish. The beginner should not be too sure of his identifications, but he need not be discouraged when his mistakes are pointed out. It is surprising how many mistakes are made by trained geologists who do not specialize specifically in fossils.

A major problem in studying Pleistocene organisms is to determine whether the finds are ancient or recent. In listing the Pleistocene fossil vertebrates, it is very likely that mistakes will be made because practically every kind of vertebrate living

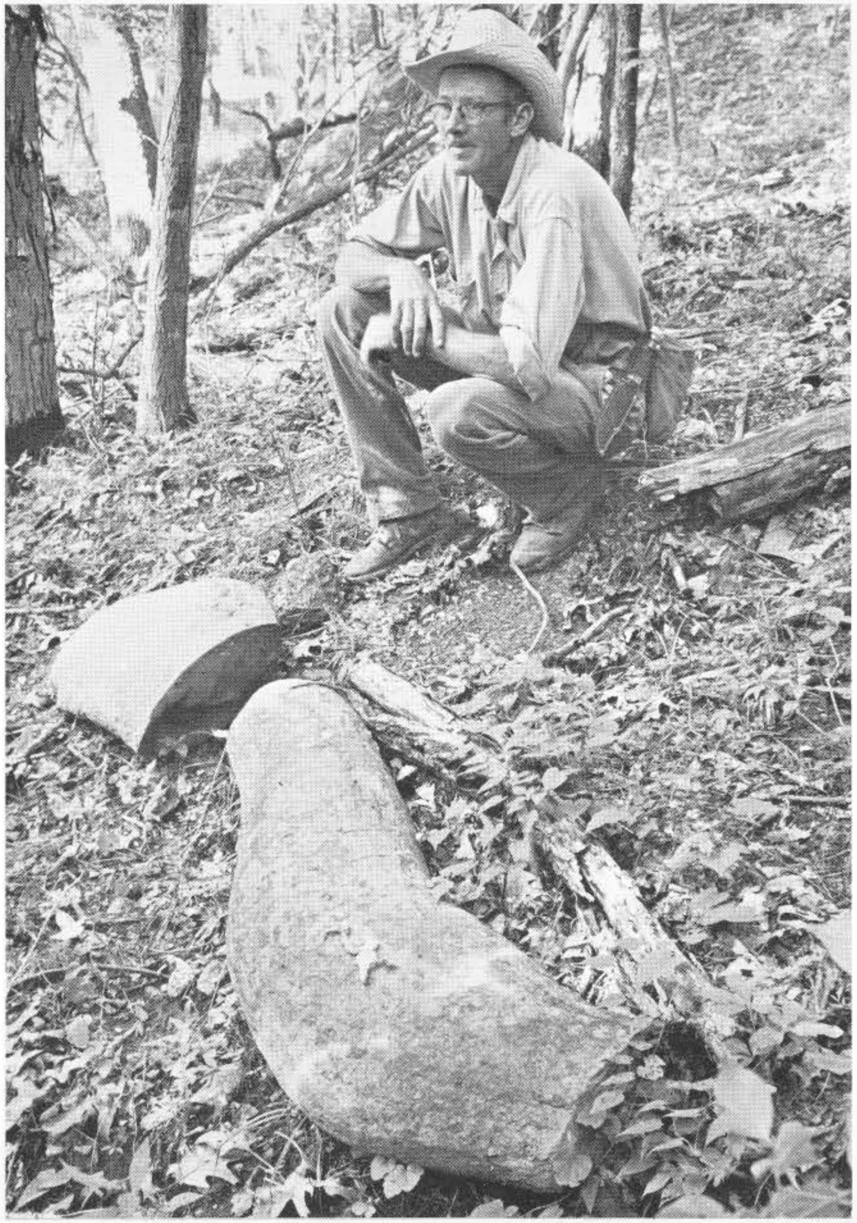


Fig. 12. A pseudofossil. This large concretion was found in Pennsylvania shale on the farm of Mr. L. F. Farbis, about 2 miles north of Chillicothe. A news story reported this specimen as a "joint of a dinosaur." Photo through courtesy of Mr. Bill Plummer, editor of the Constitution-Tribune at Chillicothe, Missouri.

in Missouri today was present before "Recent" geological time. On occasion, the bones of a recent animal are much less well preserved than those of an animal from far back in the Pleistocene.

If we could take advantage of the Carbon-14 method to determine the age of the many finds, it would be possible to refer most of them to the "recent" or "fossil" category with considerable assurance. However, this is very costly, and there are relatively few institutions that have the facilities required. It follows that some of the guesses may be bad, but this should not materially affect the over-all picture.

Recording, Naming, and Classifying Fossil Material

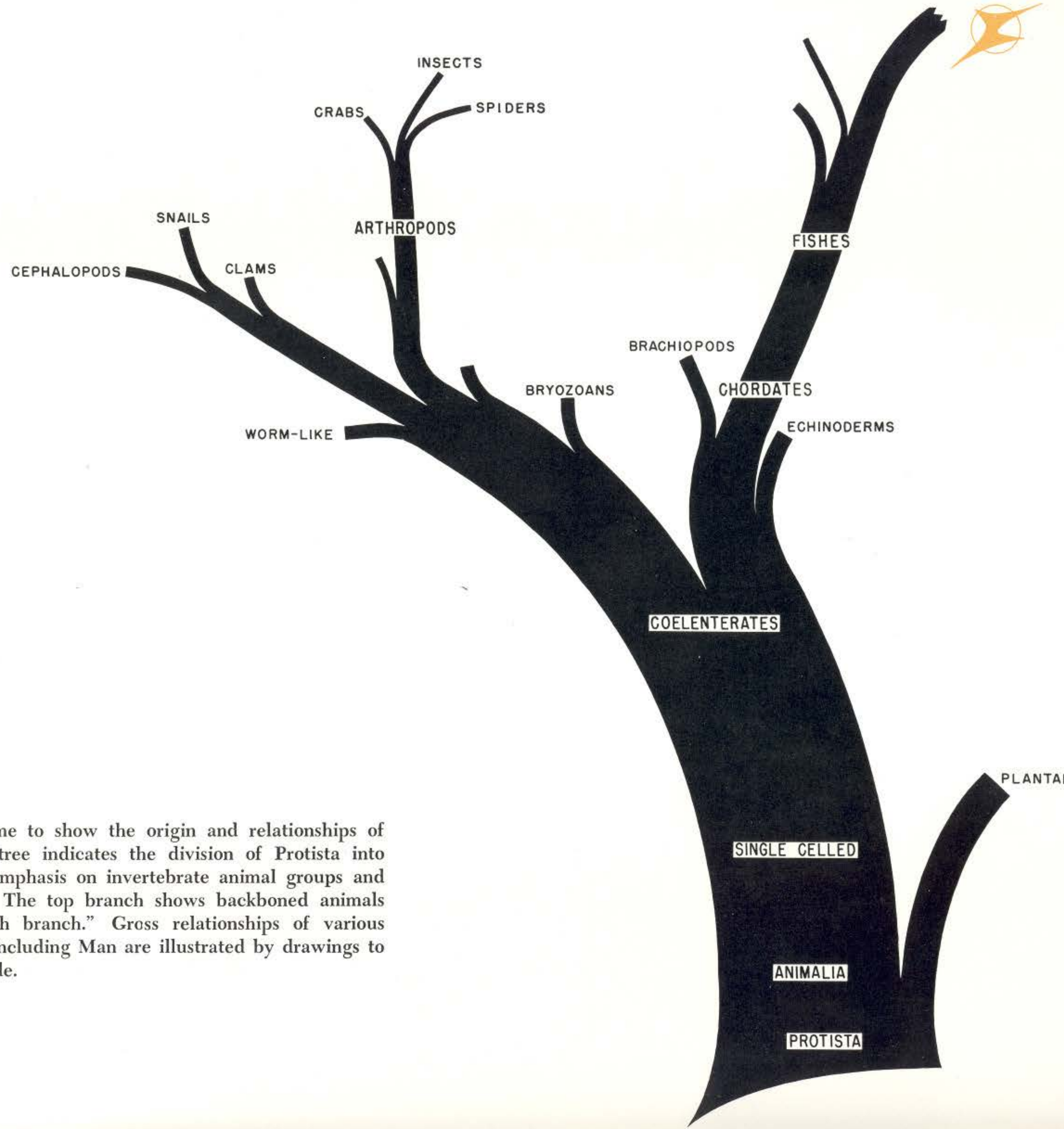
RECORDING LOCALITIES.—In the following pages, reference numbers like MGSQV-1010 will be seen frequently. These numbers refer to localities in Missouri from which Pleistocene vertebrates have been reported. Each locality has been assigned, arbitrarily, a number in the MGSQV-1000 series (Missouri Geological Survey Quaternary Vertebrates). These numbers are recorded in the files of the office of the Missouri State Geological Survey at Rolla together with all available information on each locality. The record, presented in these pages, lists these localities and gives the information that may be of interest to the general public. In some cases, where scientific investigations are now in progress, the exact location is omitted to prevent inadvertent interference with these investigations. In such cases, the locality reference number is placed in brackets, [MGSQV-1010], and qualified investigators may obtain further information concerning the finds by addressing the Director of the Missouri Geological Survey at Rolla, Missouri.

Although listed consecutively according to assigned number, two groups of localities are distinguished. The first includes localities of special historic interest as well as those that give promise of reward for further investigation of the original or similar situations. These are followed by an asterisk, MGSQV-1011*. The second group are those localities that are included to complete the record to date and to illustrate what may be expected by the keen observer in almost any part of Missouri. For the most part, this second division is one of general rather than specific locations of the finds.

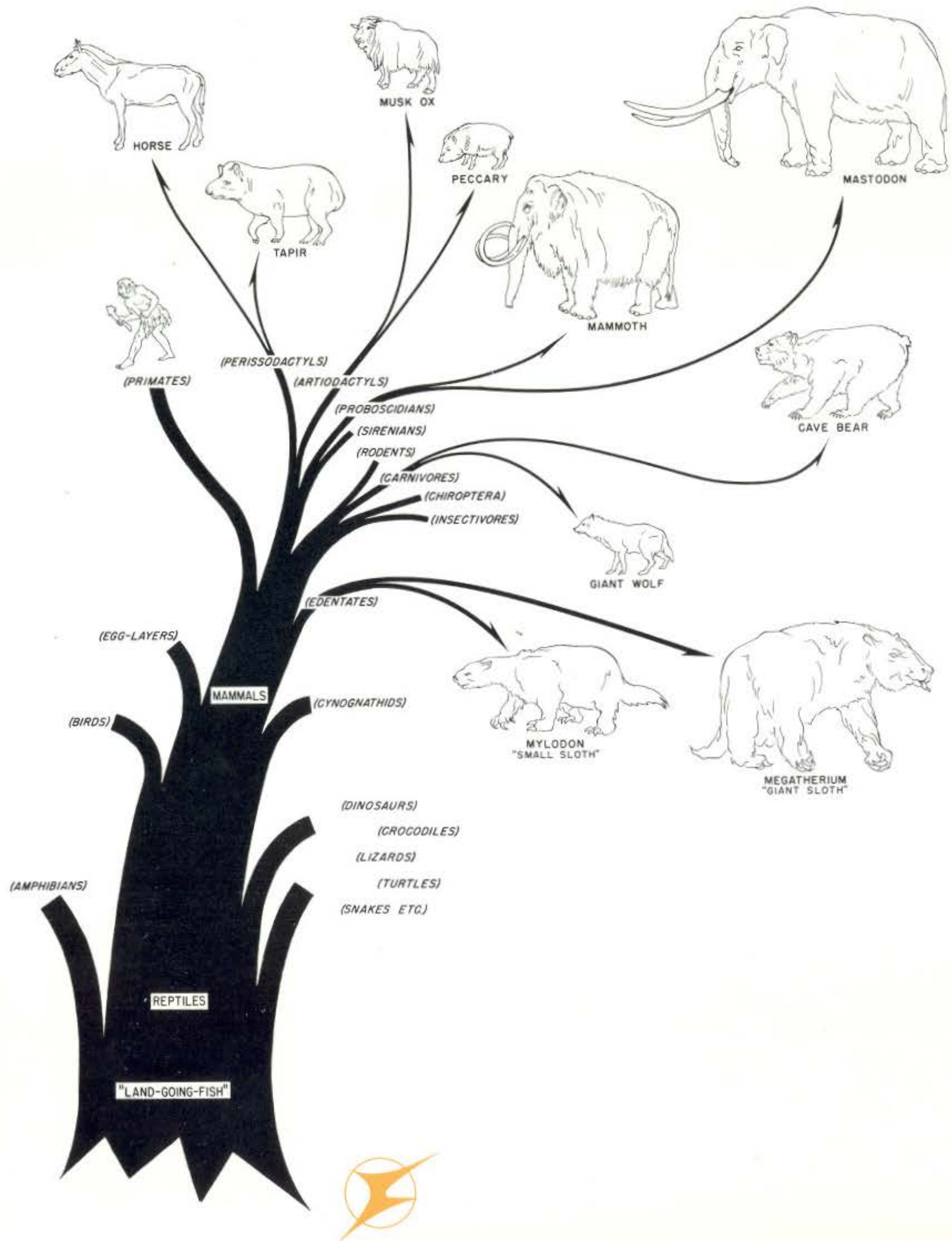
This serially arranged list of locality numbers and a locality listing by counties are to be found in the Appendix.

The above method of cataloging fossil material is one of the many commonly used in university or museum depositories. Cataloging serves a number of purposes, the most important being that it keeps the individual fossil specimens in an orderly arrangement and retains the identity of the specimen's discovery position, both geographically and temporally. Without such an arrangement, the specimens would lose much of their scientific value, and they would become nothing more than isolated curiosities. It is for this reason that it is very important for anyone who finds a fossil or unusual object for which he has no immediate explanation to note as closely and as carefully as possible the position, location, and conditions under which the object is discovered.

NAMING THE ANIMALS.—Another very important method of recording animals and their fossil remains is to give them all scientific names. But the question most often asked is "Why do you use big names for animals instead of common names like *dog* or *cat*?" This is a question that every scientist has heard many times. To him the "big names" of the nontechnical reader are so ordinary that the scientist is at a loss sometimes to explain. He may point out that in one community, the common name for a given animal means something very different in some other community. The farm boy of Missouri, for



The Tree of Life, a scheme to show the origin and relationships of plants and animals. The tree indicates the division of Protista into plants and animals, with emphasis on invertebrate animal groups and early backboned animals. The top branch shows backboned animals extending beyond the "fish branch." Gross relationships of various typical Ice Age mammals including Man are illustrated by drawings to approximately the same scale.



HORSE
MUSK OX
PECCARY
MASTODON
TAPIR
MAMMOTH
(PRIMATES)
(PERISSODACTYLS)
(ARTIODACTYLS)
(PROBOSCIDIANS)
(SIRENIANS)
(RODENTS)
(CARNIVORES)
(CHIROPTERA)
(INSECTIVORES)
CAVE BEAR
GIANT WOLF
(EDENTATES)
(EGG-LAYERS)
MAMMALS
(CYNOGNATHIDS)
(BIRDS)
MYLODON
"SMALL SLOTH"
MEGATHERIUM
"GIANT SLOTH"
(DINOSAURS)
(CROCODILES)
(LIZARDS)
(TURTLES)
(SNAKES ETC.)
(AMPHIBIANS)
REPTILES
"LAND-GOING-FISH"

instance, speaks of trapping a "civet" or "civet cat" and in doing so is describing a small spotted animal. He may or may not know that this animal, a spotted skunk closely related to the striped variety, is very different from the "civet cat" of the boy "south of the border". The technical name of the Missouri boy's animal is *Spilogale,* and this is almost as simple as civet! Actually, *civet* is the common name used by zoologists for a group in the family Viverridae which is quite distinct from the family Mustelidae which includes such animals as skunks, badgers, and mink. In Asia and Africa, the name *civet* is applied to any of a considerable variety of animals, none closely related to the skunks. In this connection, it might be well to remind ourselves that the "buffalo" of our western plains is not a buffalo but a *Bison;* the "prairie dog" is not a dog but a rodent; and the "horned toad" is not a toad but is a lizard! Animals (and plants) are given technical names according to definite rules that apply throughout the world—a universal scientific language.

CLASSIFYING ANIMALS.—The possibility of being misunderstood is not the only reason for using a universal language to describe organisms. Such an agreement on terminology also makes it possible to express our opinion on the degree of relationship among the various kinds of plants and animals and, thereby, to sort them out or classify them into natural groups. For instance, all warm blooded animals that are clothed with hair are grouped together in the class Mammalia rather than with some other class such as the one for Fishes, or the one for Amphibians, or the one for Reptiles, or the one for Birds. All organisms are grouped in one or another of three Kingdoms—one for animals, one for plants, and one for organisms that are neither animals nor plants. These kingdoms are divided into lesser groups, the *phyla,* and the phyla into still lesser groups, the *classes.* In the class Mammalia and in each of the other classes, there are several still lesser groups that are named *orders,* such as the order Proboscidea (the elephant-like group) or Perissodactyla (the odd-toed, hoofed group).

Each order consists of one or more *family* groups, such as the Rhinocerotidae, Tapiridae, and Equidae (all in the Order Perissodoctyla). Family groups are subdivided into generic groups like *Equus* and even subgeneric groups, like *Equus (equus).* The genus is made up of one or more lesser groups, the species. *Equus complicatus,* a common ice age horse, is a good illustration of a species name, and the simplified classification of this horse goes something like this:

Kingdom—Animalia (rather than plant)
- Phylum—Vertebrata (backboned)
  - Class—Mammalia (warm blooded, hair covered)
    - Order—Perissodactyla (odd-toed, hoofed)
      - Family—Equidae
        - Genus—*Equus*
          - Species—*Equus complicatus*

The common house cat may be recorded as follows:

- Kingdom—Animalia
  - Phylum—Vertebrata
    - Class—Mammalia
      - Order—Carnivora (flesh-eating)
        - Suborder—Fissipeda (split fingers as opposed to webbed)
          - Family—Felidae
            - Genus—*Felis*
              - Species—*Felis domesticus*

It should be noted that the generic and specific names are italicized and that a species name is always the combination of the genus name plus a descriptive term. The spelling of the word *species* is the same for singular and plural.

In deference to the lay reader we shall use a minimum of technical names, and in each case there will be given the "common Missouri name," if one exists.

While it is customary to give each find not only a generic name, such as *Mammuthus,* but also a specific name, like *Equus complicatus,* most of the Pleistocene finds are so fragmentary that specific names and sometimes even generic identifications are not certain. To put specific names on the various Pleistocene remains under these circumstances is not ordinarily helpful to other scientists, and the general reader has little interest in this aspect. The major contribution for the present is to record as accurately as is possible the location of the finds so that the specialist can study and compare all of the available materials that represent a group in which he has a special interest. Toward this end the various groups will be discussed in general rather than specific terms.

With few exceptions bones and teeth offer the only means for studying fossil vertebrates, thus an explanation of the more common terms applied to the skeletal parts and teeth of animals is to be found in later paragraphs.

DEATH TRAPS AND SITES OF PRESERVATION

When we consider the constant threat of destruction to each creature in nature, it is evident that within an area the size of Missouri thousands of animals must perish each year. Still, when we traverse the wooded areas and the meadows of the state, skeletons are seldom noticed. Nature has a way of disposing of this waste, and when one does find a skeleton on the forest floor it is scattered and broken, and one expects that it will not be long enduring. Certainly, if the record of Ice Age fossils were dependent on the ordinary events like those of today in Missouri, the record would be very meager.

Preservation in glacial till is not the answer. Actually, there are at present no more records of bones from the glacial till than one can count on the fingers of one hand. Even the mantle of loess that covered vast areas has not preserved many records of vertebrate life, as is evident from a perusal of the appended list of fossil localities. The abundance of the record is dependent on some sort of special trap or situation connected with the Pleistocene—conditions that inhibited the normal process of decay. In some finds, this special event is not evident, but in a few instances the source of abundance is clear.

Swamps

Perhaps the most famous of Nature's animal traps are the tar pits of Southern California, but one does not have to leave Missouri to find spectacular accumulations of Ice Age bones. In our state, copious drainage from the margins of the ice sheets presented during the major part of each year of the Ice Age a very complicated and constantly changing pattern. In a broad belt between the ice and the better organized streams to the south, poorly drained patches of swampland were common, and each contained a lush growth of coarse, attractive vegetation. In many cases, the vegetation, or the "bait" as it may be thought of, concealed a deep layer of muck into which many an animal was lured to his destruction.

These swamps were selective and in most cases may well be called "mastodon traps". It is not a coincidence that where remains of large numbers of mastodons are found it is uncommon to find skeletons of other animals, excepting perhaps, sloths. The bison, elephants, and horses, for instance, were more strictly grazing animals and, therefore, frequented the grassy meadows. The mastodons, on the other hand, did not have efficient grinding teeth and had to feed on coarse vegetation that called for crushing only—the typical swamp vegetation.

The name of Albrecht K. Koch* and the collecting of mastodon bones in Missouri are synonymous. In the first half of the 19th Century, Koch collected hundreds of teeth and skeletal parts of mastodons in various parts of Missouri, wrote many accounts about them, and displayed skeletons in various cities of the United States and in several foreign countries. Mr. Koch operated a museum in St. Louis, and as a showman was rivaled only by P. T. Barnum who made famous such features as the "Fish Woman" and the "Stone Man" or "Cardiff Giant."

Albrecht Koch, or "Dr. Koch" as he started to call himself about 1845, had little knowledge of anatomy and no training whatsoever in geology, consequently he used scientific terminology in a most confusing manner. In a pamphlet published by him in Europe in 1843, he described himself as follows:

Previous to my commencing this Treatise, I wish particularly to mention that I have not only devoted the greater part of my life to the theoretical study of Natural History, but have also made myself intimately acquainted with the practical part of it.

Koch's flair for the spectacular led him to interpret all data in connection with his mastodon finds as proof that these animals were contemporary with Man. Accuracy of location and details of anatomy did not greatly concern him, and he felt free to make feet of plaster for his skeletons to conform to his ideas, if the feet were originally missing. However, with some knowledge of how the man thought and interpreted his data, one finds that his original accounts of discoveries can be very useful. Of the several mastodon "swamp traps" known in Missouri, Koch played an important part in the exploration of at least three as indicated below.

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*In much of the American literature the name is anglicized as Albert Carl Koch.

BOURBEUSE RIVER SWAMP.—Under the heading "The Discovery of Remains of Mastodon in Gasconade County, Missouri", Koch (1843) described the Bourbeuse River find as follows:

It is with the greatest pleasure the writer of this article can state, from personal knowledge that one of the largest of these animals has actually been stoned and buried by Indians, as appears from implements found among the ashes, cinders, and half burned wood and bones of the animal.

The circumstances are as follows:

A farmer in Gasconade County, Missouri, lat. 38 degrees 20 minutes N., lon. 92 degrees W., wished to improve his spring, and in doing so, discovered above five feet beneath the surface, a part of the back and hip bone. Of this I was informed by Mr. Wash, and not doubting but the whole, or nearly the whole skeleton might be discovered, I went there and found as had been stated, also a knife made of stone. I immediately commenced opening a much larger space; the first layer of earth was a vegetable mould, then a blue clay, then sand and blue clay. I found a large quantity of pieces of rocks, weighing from two to twenty-five pounds each, evidently thrown there with the intention of hitting some object. It is necessary to remark, that not the least sign of rocks or gravel is to be found nearer than four to five hundred yards; and that these pieces were broken from larger rocks, and consequently carried here for some express purpose. After passing through these rocks, I came to a layer of vegetable mould; on the surface of this a spear and axe; the spear corresponds precisely with our common Indian spear, the axe is different from any one I have seen. Also on this earth was ashes, nearly from six inches to one foot in depth, intermixed with burned wood, and burned bones, broken spears, axes, knives, etc. The fire appeared to have been largest on the head and neck of the animal, as the ashes and coals are *much deeper here than in the rest of the body; the skull was quite perfect, but so much burned, that it crumpled to dust at the least touch; two feet from this were found two teeth from the jaw, but mashed entirely to pieces. By putting them together, they showed the animal to have been much larger than heretofore discovered.*

It appeared by the situation of the skeleton, that the animal had been sunk with its hind feet in the mud and water, and unable to extricate itself, had fallen on its right side, and in that situation was found and killed as above described, consequently the hind and fore foot on the right side was sunk deeper in the mud and thereby saved from the effects of the fire; therefore I was able to preserve the whole of the hind foot all but some few bones, that were too much decayed to be worth saving. Also between the rocks that had sunk through the ashes, was found large pieces of skin, that appeared like fresh tanned sole leather, strongly impregnated with the ley (lye) from the ashes, and a great many of the sinews and arteries were plain to be seen on the earth and rocks, but in such a state as not to be moved, excepting in small pieces, the size of a hand, which are now preserved in spirits.

According to Mr. Helmer Turner the location of this find must be 2½ miles south of the Gasconade County line in Phelps County near what is known as Foley's Spring (SE¼ NE¼ NE¼ sec. 8, T. 39 N., R. 6 W.). The land once belonged to Mr. Wash, and there is a Wash School and a Wash Cemetery in the vicinity.

Koch's evidence of the contemporaneity of Man with mastodon here has not generally been accepted, although it is reasonably sure that Man did see mastodons. It is likely that the "flesh", "sinews" and "arteries" Koch said he preserved in spirits represented something entirely different. He did not mention it again in his many subsequent pamphlets reviewing the subject.

The bones from this find were not kept separate from other collections, and it is not possible to be certain today where they may have been dissipated.

POMME DE TERRE SWAMP.—In 1806, B. S. Barton* wrote to Cuvier† telling of the report of a traveler who had seen thousands of mastodon bones in this region and had collected 17 tusks, some a foot in diameter and 6 feet long (Cuvier, 1834, p. 270). This was said to be near the river of the Osage Indians, presumably a locality near the Pomme de Terre or "Big Bone" River, a tributary of the Osage River, in Benton County, Missouri, "latitude 40 degrees, longitude 18 degrees". This is obviously incorrect, for it describes a point in the Atlantic Ocean! Koch's excavation is thought to have been on the Brashear Farm, (SW¼ NW¼ NE¼ NW¼ sec. 9, T. 33 N., R. 22 W.). This is about a tenth of a mile south of the Benton County line in Hickory County. This is the best information available from inhabitants of the vicinity as verified by Mr. Helmer Turner.

Mr. Koch's description is interesting but must not be interpreted literally in all its details. To quote:

There is every reason to suppose that the "Pomme de Terre" at some former period was a large magnificent river, from one half to three fourths of a mile in width, and that its water then washed the high rock bluffs on either side, where the marks of the waves are perfectly plain; they present a similar appearance to that of the Missouri and Mississippi. Since the deposit of these bones, the bed of the "Pomme de Terre" has received several different strata, which occur as follows:

*Benjamin Smith Barton (1766-1815) was an American naturalist who was Professor of Natural History and Botany at the College of Philadelphia, now the University of Pennsylvania from 1790 to 1815.

†Baron (Georges) Leopold Chretian Frederic Dagobert Cuvier (1769-1832) was a famous French naturalist.

Up to the time of the destruction of these animals, the original stratum forming the bed of the river consisted of quicksand. On the surface of this, and partly mixed with it, the bones were found. The next stratum is a brown alluvial soil, three or four feet in thickness: This contained and enveloped the bones. This stratum was mixed with a great quantity of vegetable matter, generally in a fine state of preservation; and what is still more surprising, all these vegetable remains are tropical, or of very low southern latitudes. They consist of large quantities of cypress burs, wood and bark; and a great deal of tropical cane, and tropical swamp moss; several stumps of trees, resembling logwood. Even the greater part of the flower of the Strelitza class, which was when buried not full blown, was discovered imbedded in this layer, also several stems of palmette leaves, one in which the fibres were nearly perfect. This stratum also contained iron ore.

Next came a stratum of blue clay three feet in thickness; then succeeded one of gravel, from nine to eighteen inches in thickness, so densely compressed so as to resemble pudding-stone. Then occurred a layer of light blue clay from three to four feet thick. On this, was another stratum of gravel, of similar thickness and appearance to the one first mentioned. This was succeeded by a layer of yellowish clay, from two to three feet thick; over this a third layer of gravel, of the same appearance and thickness; and lastly, the present earth's surface and soil, consisting of brownish clay mingled with a few pebbles and covered with large oaks, maples, and elms, as nearly as could be ascertained, from eighty to one hundred years old. In the center of the above named deposit was a large spring, which appeared to rise from the bowels of the earth, as it was never affected by the severest rain or the severest drought.

WARSAW SWAMP.—There is considerable doubt concerning the location of these finds, and it is possible that they are in part of the Pomme de Terre area. Inasmuch as the collectors, Case and Redman, made a business of selling their "skeletons", it is likely that they welcomed any publicity that did not reveal the exact details of the finds. The *Jeffersonian Republican*, November 12, 1842, reported as follows:

The recent discovery of bones by Messrs, Case and Redman of Warsaw, transcends anything of the kind yet offered to the public in point of number and size. The place where these bones were found is about two miles from town, and is familiarly known by the western people as a lick. The number of different heads found amounts to seventy or eighty, and the large amount of detached teeth shows that a greater number of these monsters have found a common grave in this basin.

And again, from the *Jefferson Enquirer* of January 26, 1843:

We had last week exhibited in the State House the bones of the great Mastodon or Behemoth found in the vicinity of Warsaw, Benton County, Missouri. They were brought to the city some ten days ago by Mr. Case.

In addition to the bones of the Mastodon, Mr. Case brought with him a large number of other bones belonging to various animals.

I find no record to indicate what part, if any, Mr. Koch had in the exploration of the "Warsaw finds". If the site was in the Osage River bottoms near Warsaw, it would now be inundated by the headwaters of the Lake of the Ozarks.

KIMMSWICK SWAMP.—Mr. Albrecht Koch gave an account of this locality in a bulletin published in St. Louis on July 11, 1839 as follows:

In various parts of this vast continent, remains of the Mastodon have been occasionally disinterred. I have recently obtained an uncommonly large, entire, head of the Mastodon, *together with many of the other bones. The circumstances attending its discovery are these:*

A few weeks since, on receiving information from a friend that many large bones were found on the land of Captain Palmer & Company, about 22 miles south of St. Louis, I immediately proceeded to the spot; and through the politeness and encouragement of Captain Palmer, commenced operations, which proved more successful than my most sanguine anticipations. The outside formation and peculiar constructions of the upper part of the head is different from that of any quadruped in Natural History that I am acquainted with. It is composed of small cells about three quarters of an inch square, and about three inches deep, covered by a thin cranium; attached to the upper jaw in the snout which projects about eighteen inches over the lower jaw, and which has never been described before.

The position of the tusk in the head has been a subject of discussion among Naturalists, and they had been placed in the same manner as those of the Elephant. It gives me pleasure to state, that I can now settle this question—for in the head which I discovered, I found a tusk firmly implanted in the socket, and had it conveyed with great care to my museum, but owing to the ignorance and carelessness of a laborer, in carrying it upstairs, it was broken off, but its position can be proved by a number of gentlemen of the highest respectability. The tusks are not situated in the same position as those of the Elephant, as was supposed by some. They diverge outwards from the head with the convexity forward, and the point turning backwards in the same plane with the head; the tusk found in the head measures ten feet, one inch from the base to the tip, following the outside curvature, and two feet in circumference near the socket. The other tusk measures only nine feet—part of the root is wanting. When placed in the head in their original position, the distance from tip to tip, measures sixteen feet. I may add, that it required two stout men to carry the largest tusk, and two yoke of oxen to carry the head and tusks from the place of disinterment to the museum.

Besides the Mastodon's head, I have found near the same place, several highly interesting remains of antedeluvian animals, one of which especially merits attention. It is the head of a nondescript animal, which appears to have been superior in size to the largest elephant, and which resembles somewhat the Mastodon in the hind part of the head, but the front part is entirely different; and until it is recognized or proved to have been previously discovered, I shall name it Koch's Missourian, in honor of the state it is discovered in, and intend, in a very short time to give a minute description of it, as well as of a great many relics not herein mentioned.

Koch's excavations of this site were probably not the first and possibly not the most extensive. The area became a mecca for bone hunters for the next hundred years, and much material found its way into now forgotten private collections. Systematic excavations, apparently the first to approach modern techniques, were started in September of 1940 and continued with interruptions into the spring of 1942 by Mr. R. M. Adams, a member of the Missouri Archaeological Society and amateur archaeologist. In his report (Adams, 1953), this investigator, although adding little to the bone or artifact collection, presented many data by means of which the details of the original accumulation locality are reconstructed.

SEDALIA SWAMP.—Attention was called to Mastodon bones found near Sedalia in Pettis County, Missouri, by Broadhead in 1881 (p. 517). The bones were found about four miles southeast of Sedalia in Section 25, T. 45 N., R. 21 W., during the winter of 1879-1880 by Mr. R. A. Blair. An area of swampy land about 20 feet in diameter, surrounding a spring somewhat more than 100 yards from the creek (Flat Creek?), was excavated to a depth of 8 feet. In an area not more than 16 feet in diameter was found the remains of animals of all ages, representing possibly as many as a dozen individuals.

The bones were in "a light spongy peat humus" below which was an undetermined thickness of gravel. Flint instruments and a stone hammer were excavated with the bones, but the relationship to the bones was not noted. Because this is the site of a spring, it is possible that these artifacts were dropped here in comparatively recent times.

The bones were given to the University of Missouri where they are recorded in the Department of Geology as "V.P. 659". Apparently the bones disintegrated very rapidly, for when I first examined a great bulk of fragments in 1919, little of value remained excepting a few vertebrae, a humerus, several lower and upper jaws with dentition, and a considerable number of separate teeth. No other animals seem to have been associated with the mastodons at this locality. The humus in which the bones were found is said to have contained pieces of wood resembling cypress.

VIENNA SWAMP.—In April of 1951, Mr. John Streumph was operating a dragline on the farm of Andrew Buschmann. This is about 4 miles west and a little south of Vienna off Missouri Highway 42 (Sec. 26, T. 40 N., R. 10 W.) in Maries County, Missouri. The farm includes swampy stretches, locally called "crawfish land," along Maries Creek. The story of the finds was told in interesting detail by Dwight Pennington in the *Kansas City Star* of April 22, 1951.

Mr. Streumph excavated a swampy stretch across a cornfield to re-establish drainage. He had left the dirt from the dragline in piles to dry so that later it could be leveled. When he returned, he saw some teeth and bones on the mounds and with the help of Marvin Helms collected considerable material to show to Mr. Rayburn Brooks, the County Agent. It was through Mr. Brooks that the curator of the State Museum, Mr. Donald Johnson, was contacted. Under the direction of Mr. Johnson, more than 200 teeth and bones were taken from the central part of the peat bog which extended in a stretch 30 feet wide and more than 100 feet long. At the deepest part, the excavation was about 20 feet deep. Mr. Johnson is experimenting on methods of preserving the bones which disintegrated rapidly when removed from the water of the swamp. He reports that much more material may be expected, but that the excavation will be expensive because of depth and water problems.

Sinkholes

CHEROKEE CAVE SINKHOLE.—Under the title "Bones in the Brewery", Dr. George Gaylord Simpson*, in 1946, described a unique accumulation of Pleistocene skeletons which were found in a large cavern beneath the city of St. Louis. In a delightful account, he tells the history and prehistory of the passages variously known as the Minnehaha Cave, Lemp Brewery Cave, or (currently) the Cherokee Cave. At a later time, Simpson (1949) gave a more technical account of the cave deposits, their excavation, and a list of the animals found. This cave is described by J Harlan Bretz† (1956, pp. 74-80) in his comprehensive report on the caves of Missouri, published by the Missouri Geological Survey and Water Resources.

The discovery of caverns in the limestone beneath St. Louis, presumably including Cherokee Cave, was made by Gotfried Duden in the late 1820's. Later, Adam Lemp cleared

*George Gaylord Simpson (1902-   ) has been the Agassiz Professor of Vertebrate Paleontology at Harvard University since 1959.

†J Harlan Bretz (1882-   ), Professor Emeritus, University of Chicago, had been Professor of Geology at the University of Chicago from 1915 to 1947.

Fig. 13. Excavation of Mastodon bones near Vienna. Mr. John Streumph is indicating the position of some teeth to Mr. Donald M. Johnson, director of the Missouri Resources Museum. Photograph through the courtesy of Mr. Gerald Massie.

out part of Cherokee Cave, the entrance of which is near the intersection of 13th and Cherokee Streets, and built his brewery above it. The cavern provided ideal storage for Lager Beer in the early days, but with the advent of air conditioning near the end of the 19th Century the caverns were abandoned for storage purposes. For a time, part of this underground space was used for a beer garden and a "Little Theater". When the site became the property of Mr. Lee Hess, an inveterate collector of antiques, he decided to convert the cavern into an historical and geological museum. Toward that end he employed workmen to extend the area by excavating further along the debris choked passages. Mr. Hess noted that some of the debris contained bones in considerable quantity and stopped the operation temporarily to permit the study of the deposits by specialists. In the listing of Pleistocene vertebrate localities in the Appendix, this cavern is recorded as "MGSQV-1071".

My attention was called to the bones in the cavern by Dr. Courtney Werner* of Washington University late in 1945. Under his guidance and with a small group of students from the University of Missouri, there was pried from the walls of an exploration trench several skulls and many other skeletal parts of a common Pleistocene peccary, *Platygonus compressus*.

The entrance to the cave is by means of a spiral iron stair in a circular brick-lined well about 35 feet deep. At the bottom, one enters an east-west trending gallery more than 200 feet long and from 15 to 20 feet wide. This had been divided by artificial partitions into five rooms, the front of which was the former "Little Theater". At the end of the long gallery, a branch at right angles leading to the south had been excavated for a distance of about 100 feet, but the branch to the north was excavated only by an exploration trench, not far from the start of which the first bones were noted. The excavation as it appears today is shown in the accompanying diagram (Fig. 14).

The history of this cave is probably no more complex than that of many others in Missouri, but it is not simple as is testified by the deposits within the cave today. It is evident that the cracks (joints) in the limestone bedrock is of prime importance in determining the location and direction of this cavern as well as others like it. In general, as water descends through the mantle of loose rock and soil near the surface of the ground, its downward movement is checked where it encounters solid bedrock. Its further movement is restricted almost entirely to the cracks in the limestone, particularly where one set intersects another. The water is charged with carbon dioxide from the atmosphere and with vegetable acids picked up at the surface. As the acid water descends through the cracks, the limestone is slowly dissolved so that in time a few larger openings accommodate most of the rainfall that enters the soil above. When the descending water reaches the water table, its movement is chiefly horizontal along the cracks (joint systems), and these are widened so as to form long galleries. In places, the roof of such an underground channel may collapse so as to allow the mantle of loose rock and soil to be washed in, leaving a funnel-shaped depression (sinkhole) in the surface of the ground. It is likely that such a sinkhole played an important part in the final accumulation of bones in Cherokee Cave, as is pointed out later.

Subsequent to the formation of the large underground drainage system of this area that empties into the Missouri River or possibly the Mississippi, the level of the waters of this stream either rose or the place of confluence was farther away so that the drainage in the cavern ceased to carry away the materials from the surface that were washed into the cave. In four distinct stages as described by Simpson, the galleries were filled in some places nearly to the roof. At the end of each of the four

*Courtney Werner (1895-   ) has been Associate Professor of Geology at Washington University in St. Louis, Missouri since 1944.

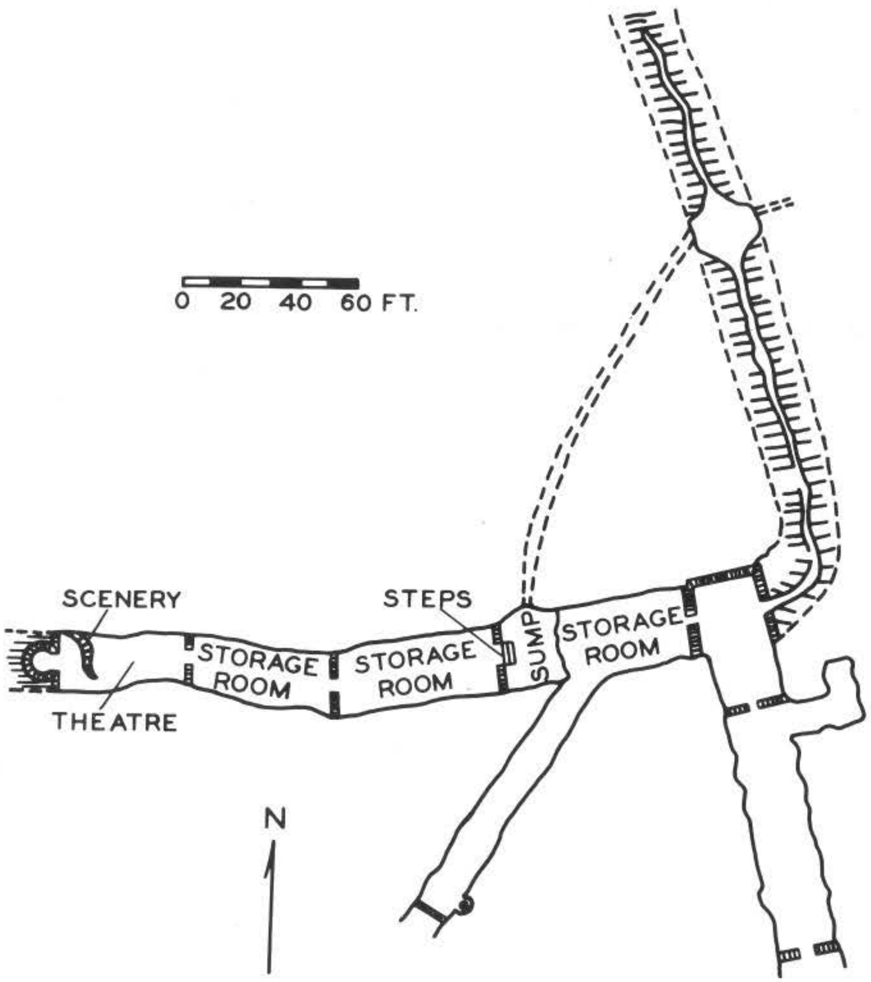


Fig. 14. Sketch plan of Cherokee Cave. After Simpson.

stages, there seems to have been an interval during which the floor remained constant except for the occasional contribution of "drip stone" (calcium carbonate dissolved from the limestone and redeposited elsewhere). The accompanying diagram, Figure 15, gives an idea of the "cave fill" that Mr. Lemp must have encountered and removed before he started to age his beer. It is this material which Mr. Hess started to excavate further and in which he found the bones.

Bones of a large number of peccaries were found in deposit number 3, but not in 1, 2, or 4. In the latter were bones of modern animals known to have lived from during the Pleistocene, but there is no proof that these particular remains are of Pleistocene age.

It is possible that peccaries inhabited this cave during the time of deposition of unit 3, but the evidence does not support this. In the first place, none of the skeletons is articulated, and many of the bones are broken. In the second place, the bones are fairly closely confined to what may be considered the "channel" of the cave. There are very few bones found in this deposit as it approaches the walls of the cavern.

Dr. Simpson interprets the deposit as detritus which temporarily accumulated in a clogged sinkhole. The "plug" of this depression ultimately was washed out, and the accumulated debris, including many skeletons, was flushed into the underground channel. This seems to be a logical explanation in the light of other sinks that have been temporarily clogged. Illustrations of this possibility are the mastodon bones which have been found in the bottom of a sinkhole in Howell County (MGSQV-1101) and the considerable accumulation of bones that is in an open hole in Laclede County [MGSQV-1091]. Something comparable to this is seen in the Enon Sink described below.

ENON SINK.—Another natural accumulation of Pleistocene bones in which a sinkhole played a major role has been called the "Enon Sink find." This discovery was made during some mining operations for lead and barite in the southeastern corner of Moniteau County near Enon in 1941. Some of the details of the skeletal finds were reported by me that same year at a meeting of the Society of Vertebrate Paleontologists (Mehl, 1944, pp. 349-350). Later, Dr. George Gaylord Simpson (1945, pp. 70-80) reviewed the history of this find and described in detail a nearly complete skeleton of a new Tapir, *Tapirus excelsus*.

The most casual examination of Enon Sink and similar sinks of the region gives evidence of a very ancient origin and complicated history. The vertebrates found in the Enon Sink were trapped during Pleistocene times, but there was clearly a long complicated history of the sink's formation before this. Some of the sinks of this general area are filled with sediments which were deposited during the Pennsylvanian Period of geologic time (Fig. 4), and it is likely that the Enon cavity was formed before that time, although sediments of Pennsylvanian age were not actually deposited in this particular sinkhole. Many of the details of this story, as well as the time element, are at present highly speculative, but the succession of some of the events must have progressed in the following manner:

At some stage following the deposition in the sea of sediments which now make up the Jefferson City rock formation, the region stood at an elevation such that the top of the groundwater body (the water table) commonly stood at about the level at which the caverns were formed. The water from rainfall and snow melt (meteoric water) that seeped down from the surface found its way through the bedrock along vertical cracks and enlarged many of these into sizable openings by solution. As the descending water tended to "pile up" on the groundwater table, its lateral movement, in time, formed fairly con-

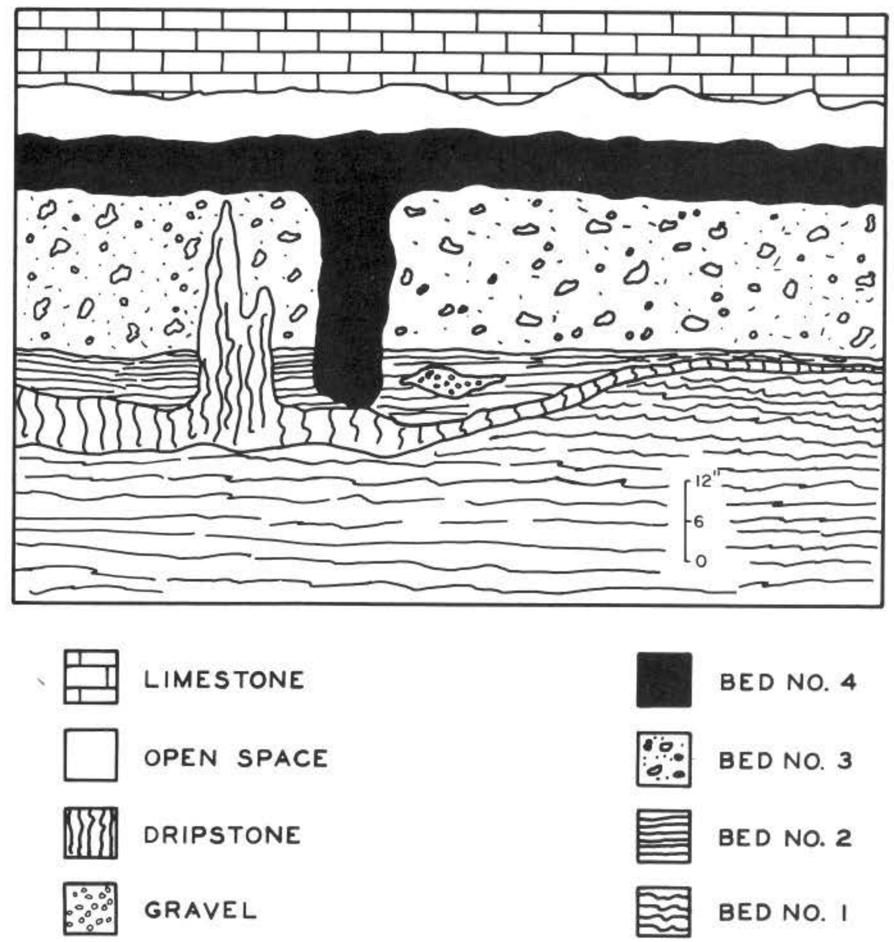


Fig. 15. Diagrammatic section of fill in Cherokee Cave. After Simpson.

tinuous channels so that much of the surface water was disposed of through springs emptying into valleys some distance away.

In the case of Enon Sink, the solution work enlarged the cavity to a diameter of about 100 feet. The roof was progressively thinned, and it ultimately collapsed leaving a large funnel shape depression in the overlying mantle. Many times this area was elevated and lowered, and during one stage, most likely before the roof of the cavern collapsed, the area stood so low that water completely filled the complicated network of underground cavities. Mineral matter from these waters was segregated to form great clusters of large tiff (barite) crystals on the walls. Masses of lead (galena) cubes that partly line the present sink and its floor probably formed at the same time. It is possible that the veinlets and isolated specks of galena in the dolomite walls were introduced at the same time, but this is a speculation that is better left to the specialists on ore deposits.

At some stage, the outlet of this cavern became plugged, possibly at the same time the roof collapsed, and the water was gradually filled with fine sediment; probably wind carried. Occasionally, coarser material was funneled into the opening to form lenses of sand or gravel. As the fill approached the surface, vegetation took root, and the area became an inviting source of food and water—a trap that captured unwary horses, tapirs, sloths, mastodons, and other animals. The fill of the cavity was so plastic that it was like a thick liquid. As animals sank into it, the skeletons were not arranged in layers but were distributed as would be expected in a very thick liquid into which one skeleton after another slowly settled to the bottom to replace material already there. Most of the bones were disassociated.

The discovery of bones in the Enon Sink is not the least of its many interesting features. For almost a century, the mining of lead and barite has been sporadic as a small seasonal opera-

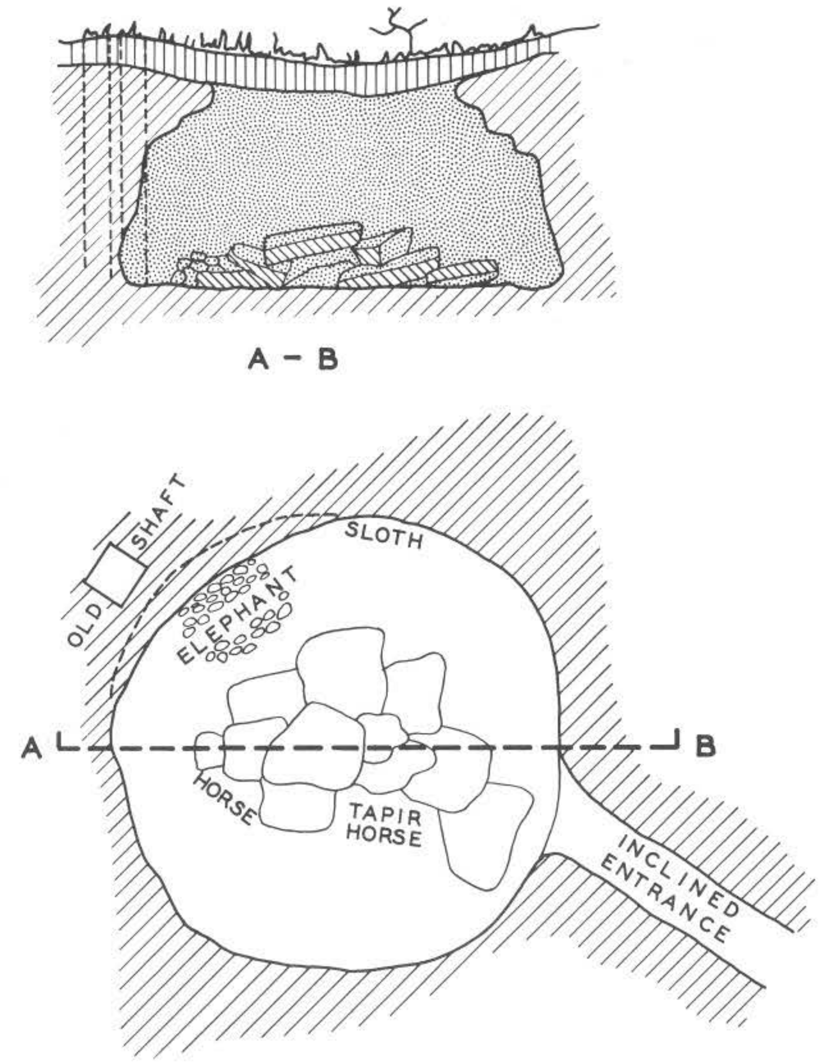


Fig. 16. Schematic cross section and ground plan of Enon Sink. Vertical lines in the cross section indicate soil and vegetable cover concealing the very plastic fill beneath. Indicated in the ground plan is the approximate position of major finds of vertebrates.

tion by one or a few individuals in this and several other filled channels or sinks in this general area. This has contributed materially to the income of the small surrounding communities. It is said that the sinks were mined for lead and barite during the "War of the Rebellion".

As early as the late 1890's, an attempt was made to dig a shaft in the Enon Sink in the search for ore, but the venture had to be abandoned because of the highly plastic, unstable material of the fill. In 1941, workers started to tunnel from the side of a close by valley. When solid rock was encountered, it was decided to blast out an open trench so as to reach the ore in the cavity.

Mr. Lloyd Grimes, at the time Principal of the Eldon High School in Miller County, called my attention to bones that had been found here. The excavation was well along before it was possible for Mr. Claude Quigley, a geology student from the University of Missouri, to watch for bones as they might be uncovered. Through his assistance, there was accumulated at the University many teeth and bones of horses, a fairly large number of bones representing tapir and sloth, two nearly complete turtle shells (carapaces), and many lesser finds. Some of the material from this sink found its way to the State Museum in Jefferson City through the efforts of Mr. Grimes and Mr. A. C. Burrill, then curator of the Museum. Some bones were placed on display at the Eldon High School, and some went to the American Museum of Natural History in New York.

In addition to the known and fairly widely distributed bones as indicated above, it is likely that the greater part of the find was ignored and broken or became the property of curiousity seekers. It was said that nearly 100 turtles were broken and thrown away!

Caves

Although there is no definition of *cave* that can be considered standard, the common practice suggests "a natural roofed cavity in rock which may be penetrated for an appreciable distance by a human", (Bretz, 1956, p. 1) normally beyond the reach of direct daylight. This omits the many shallow shelters that were found useful by the early Indians and leaves a doubtful distinction between caves and subsurface caverns that are reached through sinkhole entrances.

A compilation in 1952, mostly by Willard Farrar then a member of the Missouri Geological Survey staff, listed 210 caves from 40 counties. The number discovered increased rapidly so that in the list by Bretz in 1956 there were 437 caves recognized in 55 counties. A supplement by Vineyard, et al., in 1957 reported a total of 686 caves in 57 Missouri counties, and a second supplement by Vineyard in 1960 added about 260 new localities. At the time of this writing (April 1961), Vineyard informs me that the total is over 1000 and distributed in 68 of Missouri's 114 counties. The very large majority of these caves are in counties south of the Missouri River.

A surprisingly large number of Missourians are engaged in cave exploration with interests ranging from strictly scientific aspects to the joy of exploring where few or no others have been, or the aesthetic pleasure in viewing the many strange features of erosion and deposition in the caves. These explorers have recently developed a special interest in the bones that are to be found in many of the caves, and new finds are reported so rapidly that it is difficult to keep pace with their identification and analysis. The study of these bones and their occurrence suggests that many of the caves have changed little since Pleistocene times, and it is evident that there are two fairly distinct types of bone accumulations.

Some caves, or features in the caves, constitute mechanical traps such that a vertebrate entering the opening, either by accident or design, finds it impossible to retrace its steps. Other accumulations illustrate the normal activities of vertebrate inhabitants, the death of predators and others, or the remains of the predator's food.

Not only have cave exploring enthusiasts contributed many valuable records in the way of vertebrate remains, but within the last few months they have turned their attention with considerable success to the somewhat more difficult field of ichnology (the study of fossil footprints). Eugene Degenhardt, a student at the University of Missouri School of Mines and Metallurgy, and his associates have been very successful in photographing records of frantic clawing on cavern walls by animals that have inadvertently fallen into a "trap". Recently, Mr. Jack Reynolds, a graduate student at Central Missouri State College, has followed the rambling course of a giant "cat" for a distance of more than 1,500 feet in a cave in Perry County. He has made several plaster casts of some of the better footprints, one of which is reproduced in Figure 17.

a b

Fig. 17. Foot print of a giant cat *(Felis concolor?)* found in a Perry County cave by Ronald Oesch and Jack Reynolds. The plaster mold (a) and cast (b) record the right front foot, one of many foot prints scattered along a rambling course of 1,500 feet or more. Most of the tracks were covered by flow stone. The length of the pad impression is 5 inches as opposed to 3 inches of the average present day mountain lion.

JERRY LONG CAVE, RALLS COUNTY.—About four miles north of Perry in Ralls County (NE¼ sec. 10, T. 54 N., R. 7 W.) in the floor of a small cavern called the Jerry Long Cave, there is a deep fissure that for a long time has been a very effective trap for vertebrates of many kinds. The cavern is approached along a limestone ledge overlooking Lock Creek about 80 feet below. The entrance is about 5 feet wide and 4 feet high with the roof rapidly descending to the floor at about 8 feet from the entrance. In the floor at the back of the cave, there is a crevice somewhat more than a foot wide and 3 feet long with a vertical drop of approximately 45 feet to a lower level.

During late 1956 and early 1957, Paul W. Parmalee then Curator of Zoology, Illinois State Museum at Springfield, Illinois and Karl W. Jacobson, an assistant, collected in the cave many bones representing animals raging in size from bear to deer mouse (Parmalee and Jacobson, 1959). No skeletons were found articulated. Most abundantly represented was the Eastern wood rat which does not inhabit the region today. There was an exceptionally large number of turkey vultures which the authors account for by assuming that they were attracted by the odor of carrion and were unable to escape by vertical flight through the narrow entrance. Human remains attributable to at least two individuals can scarcely be accounted for by uncurbed curiosity or individual accident.

All of these bones may be, and probably are recent, but the appended list (Table 1) indicates what may be expected from similar caverns that existed during the Pleistocene.

BAT CAVE, SHANNON COUNTY.—Another illustration of a mechanical trap occurs in Bat Cave, Shannon County [MGSQV-1115]*. Here, at a comparatively short distance beyond a crawlway entrance, there is a deep vertical fissure at the bottom of which were found two bear skeletons, and the likelihood that much more skeletal material lies beneath in the accumulation of cave fill. At a short distance beyond this crevice, there is a pit like depression at the bottom of which was found a third bear skeleton partially enclosed in calcareous cave deposit. The walls of this pit are deeply grooved and present a graphic record of the animal's fruitless attempt to extract himself.

This third skeleton, when removed by Jerry Vineyard† early in 1961, proved to be an exceptionally large specimen of black bear *(Ursus americanus)* which was not fully mature at the time of death. In removing the encrusting cave deposit from the bones, there was found a perfect "willow leaf" point within the body cavity on the ventral side of the anterior thoracic vertebral series. The point was identified by Dr. Carl Chapman as "typical Nodina", thus, representing a culture previously known only within a limited area in southeastern Missouri (Chapman and Anderson, 1955). This dates the remains no earlier than about 1,500 years ago and probably considerably less.

It is not likely that the animal was greatly inconvenienced by this encounter with the sniper and may have carried the projectile several years before he fell into the fateful pit as he sought a suitable place for hibernation. The skeleton and point are displayed at the Geological Survey building at Rolla.

CARROLL CAVE, CAMDEN COUNTY.—Subsequent to the publication of the Bretz report on Missouri caves, a cavern of more than ordinary interest has been discovered in Camden County [MGSQV-1079] where a stream of relatively small but fairly constant volume flows beneath a low arch in dolomite of Ordovician age. The entrance to the cavern has been excavated and is now occupied by a quiet body of shallow water. At a distance of a few hundred feet, the roof descends close to the water surface and further progress demands that one lie flat on a raft which is guided along a sinuous path among the irregularities of the ceiling. Beyond, one progresses by wading where the water is shallow and elsewhere by slogging along on soft mud terraces. The cave has been surveyed with considerable accuracy for a distance of between 4 and 5 miles and as yet the end or ends have not been reached.

At about 2 miles from the entrance, Dr. Oscar Hawksley*

*Because of the uniqueness of this find, a location number is assigned although the remains are not of Pleistocene age. Location may be obtained from the Director of the Missouri Geological Survey.

†Jerry Vineyard, a former graduate student at the University of Missouri, Columbia, Missouri.

*Oscar Hawksley is Professor of Zoology at Central Missouri State College in Warrensburg, Missouri.

Table 1

Vertebrate Species Identified by Parmalee and Jacobson
from Bone Remains in Jerry Long Cave
Ralls County, Missouri

Species	Total Identifiable Remains	Minimum Number of Individuals
Eastern wood rat, *Neotoma floridana*	437	58
Woodchuck, *Marmota monax*	388	28
Black bear, *Ursus americanus*	222	12
Cotton tail, *Sylvilagus floridanus*	93	10
Fox squirrel, *Sciurus niger*	66	7
Spotted skunk, *Spilogale*	39	8
Striped skunk, *Mephitis mephitis*	37	4
Bobcat, *Lynx rufus*	33	6
Raccoon, *Procyon lotor*	38	4
Virginia opossum, *Didelphis marsupialis*	11	2
Man, *Homo*	9	2
Vole, *Microtus*	9	2
Beaver, *Castor canadensis*	5	1
Big Brown bat, *Eptesicus fuscus*	4	2
Eastern mole, *Scalopus aquaticus*	3	2
White-tailed deer, *Odocoileus virginianus*	3	1
Brown bat, *Myotis*	2	1
Gray fox, *Urocyon cinereoargenteus*	2	1
Red fox, *Vulpes fulva*	2	1
Deer mouse, *Peromyscus*	2	2
Mountain lion, *Felis concolor*	2	1
Mink, *Mustela vison*	1	1
Bog lemming, *Synaptomys cooperi*	1	1
Turkey vulture, *Cathartes aura*	291	16
Screech owl, *Otus asio*	2	1
Turkey, *Meleagris gallopavo*	1	1
Prairie chicken, *Tympanuchus cupido*	1	1

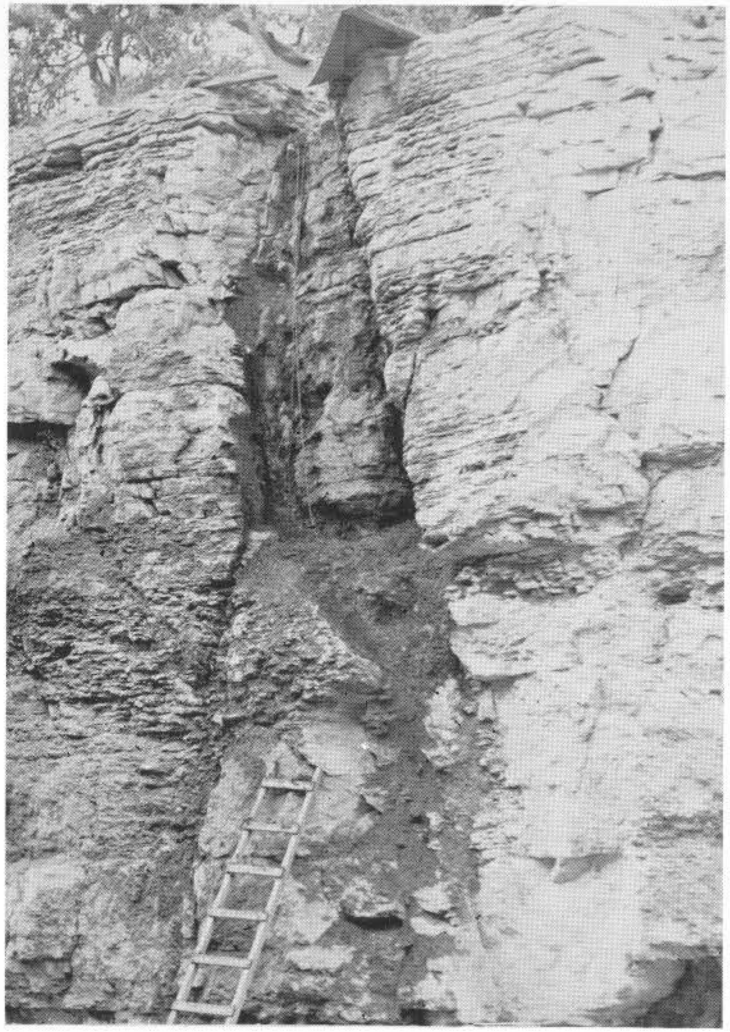


Fig. 18. A crevice in Joachim limestone near Herculaneum as it appeared during excavation. The debris contained fragmental remains of many kinds of Pleistocene vertebrates. Photograph through the courtesy of Col. Clarence M. Jenni.

and his students located the well preserved bones of an extinct giant wolf lying in the mud of a terrace. Other cave explorers had passed across the area many times breaking the unnoticed bones and trampling them into the mud. Enough was recovered so that all important parts of the skeleton are represented. With the wolf bones were found remains of a beaver, and other beaver skeletons have been found in parts of the passages.

Another record of great importance in the same cave is the upper arm bone of an extinct, giant cave bear. This came to light through a series of coincidences. The only part of the story that is certain is that Gary Schevers, a student in the Missouri School of Mines and Metallurgy at Rolla, Missouri, saw a large bone lying on a mud terrace. Disregarding the chiding of friends for carrying "an old horse bone" along with his already heavy pack, he carried it to the entrance. When it was cleaned and studied, it proved to be the only record at the time of this particular Pleistocene bear in the middle of North America! The upper end of the bone was missing, leaving a clean fresh break. Perhaps others carried the "relic" for some distance and tossed it aside. Exploration is difficult but will some day be rewarded by other parts of this animal* and perhaps other kinds. Both finds seem to record death other than that of a trapped animal.

BAT CAVE, PULASKI COUNTY.—Bat Cave [MGSQV-1083] has produced many bones representing a considerable number of individuals of *Platygonus compressus,* a Pleistocene pig-like animal. The remains show no apparent association with predators, and it seems likely that the animals were normal inhabitants of the cave. Subsequent excavation at a lower level by Hawksley and Meyers has uncovered remains of a giant extinct wolf and many smaller mammals.

*Since this writing, fragments that completed the bone were recovered by Dr. Hawksley and Richard Meyers.

COX CAVE, PULASKI COUNTY.—Cox Cave in Pulaski County [MGSQV-1103] gives promise of some remarkable finds. A small group of cave explorers under the leadership of Gary Schevers collected bones from the surface of the clay fill at two different places in this cave. The first find had been trampled by many visitors, but fragments representing two or more feet, several epipodialia, and a few teeth were recovered. They appear to represent a large canid, possibly *Canis dirus*. The second find included a large fang and bones from two or more feet of a giant cave bear. Here, only surface materials were removed, and it is reported that other bones may be expected. The remains are recorded in the geology collections at the University of Missouri as V. P. 686 and V. P. 687 respectively.

NAMELESS CAVE, CRAWFORD COUNTY.—In Nameless Cave [MGSQV-1104] not far from Sullivan, Mr. Ronald D. Oesch a teacher of Science in a St. Louis High School and associates found remains of a giant cave bear that included canines and other teeth as well as fragments of the skull and numerous foot bones. Although all the bones are now covered by cave deposit, the find seems to record comparatively recent destruction of a fine specimen through careless trampling by many feet.

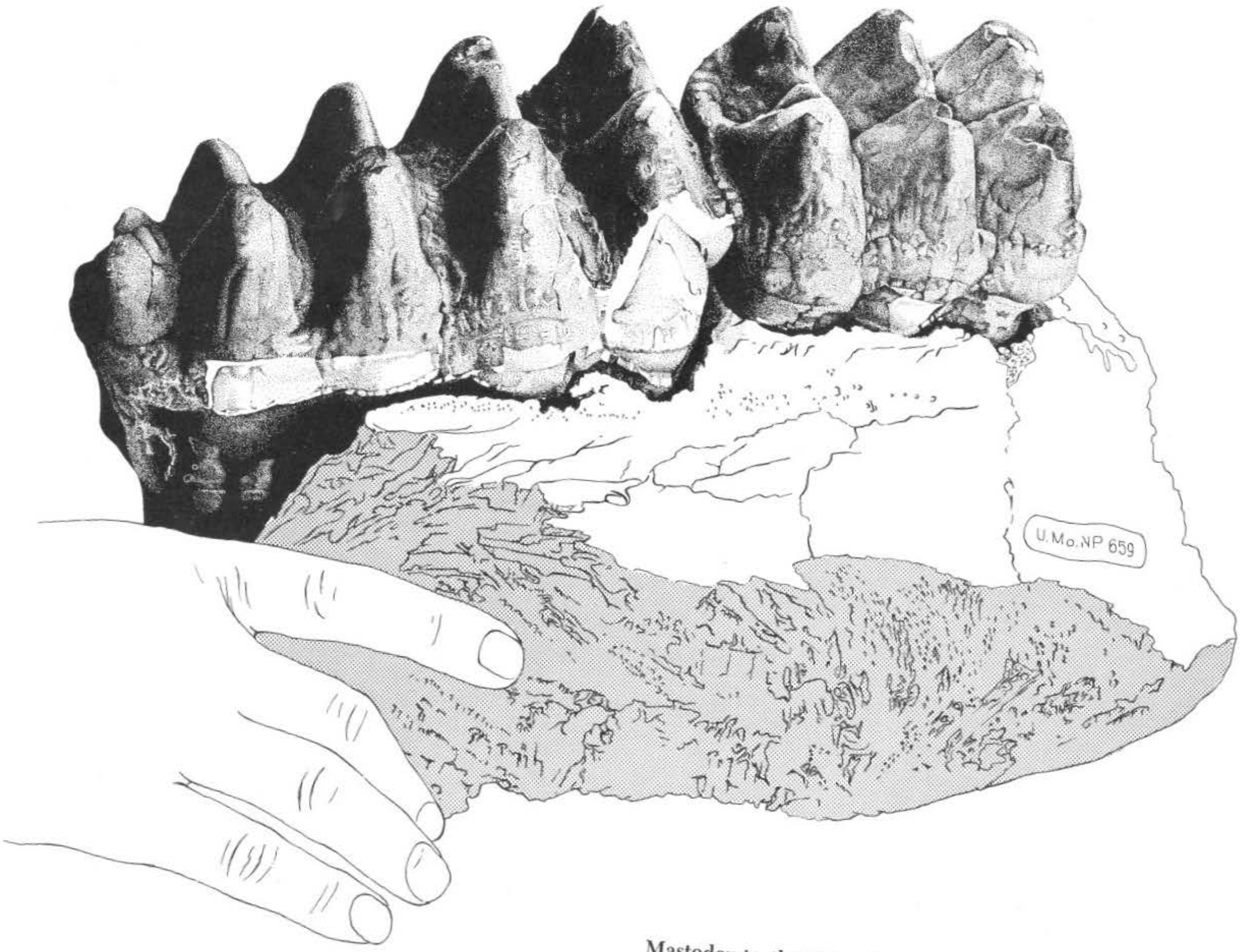
STARK CAVERNS, MILLER COUNTY.—Stark Caverns, a commercial cave in Miller County (NE¼ NW¼ sec. 28, T. 41 N., R. 15 W.), seems to record bone accumulation by predators. A considerable collection of broken pieces representing numerous deer and possibly elk is in a very narrow and difficult passage near the entrance of the cave, and assuredly it does not represent human activities.

MISSOURI'S PLEISTOCENE VERTEBRATE ANIMALS

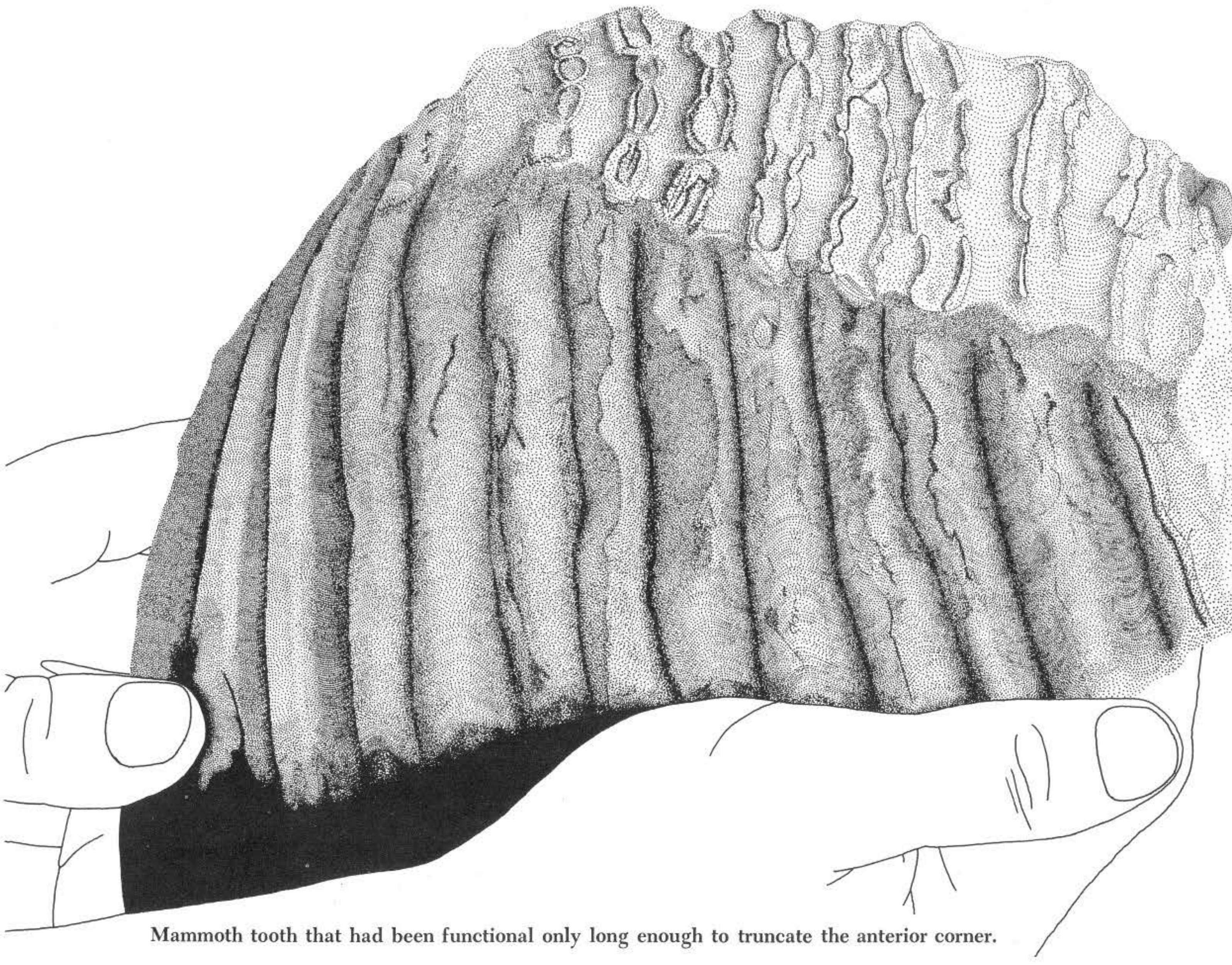
THE PROBOSCIDIANS

Remains of Proboscidians (or elephants in the broad sense of the word) have been reported from nearly half of the counties of Missouri. The geographic distribution of the recorded localities—north to south, east to west—indicate that no part of the state was favored over any other, and one may safely assume that ultimately remains of these animals may be found in all of the counties.

One who is acquainted with the appearance of present day elephants would have no difficulty in recognizing any of the Pleistocene representatives, although they fall into two rather distinct groups, and none of the genera has living representatives. In the first family, the Elephantidae, the check teeth had closely crowded crossridges, much like the teeth of living elephants, suitable for grinding tough grasses. In the second family, the Mastodontidae, the cheek teeth have conelike protuberances that fit the animal, not for grinding (triturating) but for crushing coarse vegetation such as is found in swampy areas. Both groups have a pair of large tusks in the upper jaw that are somewhat more sharply curved in the first group. These tusks are not the same as the tusks of a boar but are developed from the middle two front teeth (incisors). The succession of the cheek teeth in both groups indicates that these Pleistocene forms were long lived like the present day elephants. Instead of a permanent set replacing the deciduous or "baby teeth", the entire compliment moved slowly forward and up (or down) to the jaw surface. In this way, there was normally a new tooth appearing at the back as the front grinding (or crushing) tooth was worn down and ready to drop out. At this stage, a single large middle tooth on each side of each jaw carried the load. This was particularly true in the first family (Elephantidae). The adult of the second family (Mastodontidae) was more likely to have sets of three operating at one time, but



Mastodon teeth still in place in part of the upper right jaw.



Mammoth tooth that had been functional only long enough to truncate the anterior corner.

because less wear was occasioned by the food of this group, one seldom finds badly worn teeth of this type.

MAMMOTHS

FAMILY—ELEPHANTIDAE; GENUS—*Mammuthus*

When a new kind of vertebrate animal is found and the remains include representative parts of the skeleton, it is a little more difficult for the paleontologist to reconstruct the animal's shape and size than it is for the devotee of jig saw puzzles to complete his picture, even though some of the pieces are missing. The normal posture of the animal, as opposed to extremes of flexure of arms and legs, may be indicated in the restoration with great accuracy. The several parts of the skeleton are operated by muscular systems that are fundamentally the same in all vertebrates, and the newly discovered animal may be "clothed with flesh", so to speak, to give some details of its life appearance. However, it is seldom that details of color or body covering such as hair can be represented except by analogy with simliar forms living today. The shape, size, habits, and general appearance of the mammoths has long been known, but a life restoration based on living elephants would have been misleading in several important details. Fortunately, even the body covering, including variation in color, and the food of the mammoth have been preserved for us in the remarkable find of the "Frozen Mammoth in Siberia", as reported by O. F. Herz in 1903.

In May 1901, an expedition for the Russian Imperial Academy of Sciences under the direction of Mr. O. F. Herz, a biologist at the Academy, left St. Petersburg to excavate the remains of a frozen mammoth that had been found on a tributary of the river Kolyma, about 200 miles northwest of Bering Strait and some 60 miles within the Arctic Circle. The find was made by a Lamut, Mr. Tarabykin, in 1900. He was chasing a deer when he discovered a tusk weighing 166 pounds. In searching for more ivory, he found nearby the head of a mammoth protruding from the frozen rock debris at the base of a steep slope. The following day, with two other Lamuts, he chopped off the tusk from this head, a smaller specimen that weighed only 63 pounds. The second tusk of this animal was missing.

There is some mystery about the events culminating in the Academy's interest in this find, for not only were the Lamuts helping themselves to property that belonged to the "Crown", but they were very superstitious about things that had been

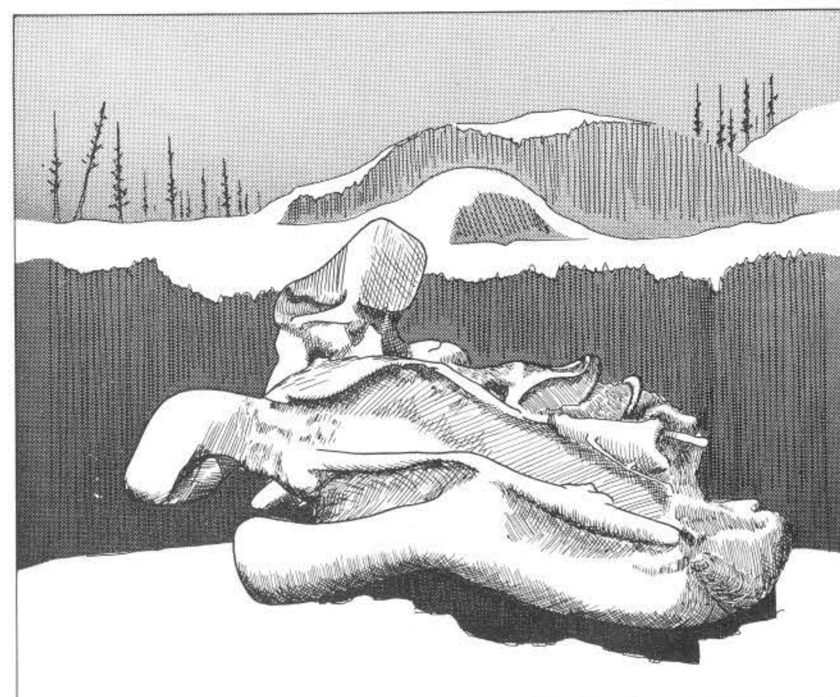


Fig. 19. The frozen mammoth of Siberia after partial excavation. View of the left side from a photograph by O. F. Herz.

buried, even mammoths. For them to tell the story, not only was to admit thievery but to confess their activities as ghouls. Perhaps this is only one of many discoveries, the others never being admitted!

When the expedition reached the site, much of the flesh from the back and head had been devoured by wolves and bears, but enough of the animal remained so as to give almost all data that might be desired, including color details of hair, and even food between the teeth and in the stomach. The day by day account of the excavation makes interesting reading. There follow a few excerpts that give a fair idea of the task the workers faced and the rewards:

In several pits in the earth I found well-preserved parts of Betula nana *(a member of the Birch family), which no longer grows upon elevated places though in well-protected spots one occasionally finds stems about as thick as a man's arm . . .*

Under the right middle part of the abdomen, which was still covered with earth, we found a yellowish-brown underwool 20 to 30 centimeters long, which, however, was so crumpled and mixed with earth that we saved only a small portion of it . . .

We also collected and deposited in a bag the underwool and bristles from the right cheek. The latter are 20 centimeters long and broken off at the ends; the color varies from black to pale blonde; the black hairs predominate, and are lighter toward the ends . . .

In the afternoon we removed the left shoulder, upon which, however, we allowed the tendon and muscular fibers to remain . . .

The flesh from under the shoulder, which is fibrous and marbled with fat, is dark red in color and looks as fresh as well-frozen beef or horse meat. It looked so appetizing that we wondered for some time whether we should not taste it, but no one would venture to take it into his mouth, and horse flesh was given the preference. The dogs cleaned up whatever mammoth meat was thrown to them.

The hairs upon the belly are reddish-brown at the base, chestnut-blonde in the middle, and yellowish at the ends.

The hairs on the left cheek are 23 centimeters long partly chestnut-brown to black, partly blonde. The under wool is not so thick as on the other parts of the skin, the hairs being yellowish as everywhere else, and 35 centimeters long.

From the stomach we removed 27 pounds of additional food remains. We then amputated the right fore leg above the shoulder blade, cut it open down to the forearm and removed the shoulder bone, which was broken in the middle, evidently injured when the mammoth fell.

The stench is not near so intolerable as during the first two days, possibly because we have grown accustomed to it.

After removing about 270 pounds of flesh we started the raising of the abdominal skin, which turned out to be still quite bulky and which we had decided must be cut up. After raising the piece of skin, which weighed about 470 pounds, we discovered, to our greatest joy, the entire tail of the mammoth. The joy that possessed us at this new discovery was so great that, lowering the skin to the ground again, we gave three loud cheers.

The skeleton of this specimen which had been in the deep freeze for thousands of years was mounted in the museum at St. Petersburg along with a life size plaster restoration in a squatting position as it was found.

The environment of this as well as other frozen mammoths was an irregular surface of glacial waste well covered with vegetation. In places, the surficial material was underlain by relatively thick ice that was characteristically cavernous and broken by crevasses. Here and there, bridges of frozen rock waste were weakened by summer thaws and an unwary migrant might well be plunged into a crevass along with the surface debris. One can visualize this "Ferdinand of the Tundra" sniffing the delicate scent of the "Arctic buttercups" as the sensitive tip of his trunk searched for tufts of moss or grass. Suddenly, his mouth filled with unchewed food, he was plummeted into darkness as the bridge gave way. In the fall, his hip was broken as was one upper arm bone. It is likely that he was so suddenly buried by debris that he was not conscious of his fate. To date frozen remains of nearly 50 mammoths have been found in various parts of the world, but only four approach completeness.

A very different interpretation of the events leading up to the frozen mammoth was suggested by Ivan T. Sanderson in his recent (1960) article in the Saturday Evening Post magazine on "The Riddle of the Quick-Frozen Mammoth". The point of departure appears to be Mr. Sanderson's assumption that this flesh *was perfectly preserved*. At any rate, the reader will enjoy this delightfully told alternative story, although subsequent writers such as Farrand (1961) have failed to agree.

Mammoths in Missouri.—Missouri's common Ice Age "Elephant" is known as *Mammuthus primigenius,* a genus which was circumpolar in range. It is safe to assume that all the individuals of this genus resembled closely the old patriarch described above in that they had heavy matted wool-like undercoats of yellowish-brown color and outer coats of bristle-like hair predominantly dark brown or black varying toward ash blonde at the frayed tips. It is likely that there was a seasonal change in color from dark brown or black to light gray. The average size of this kind of elephant was slightly smaller than the Indian elephant of today.

A study of the finds of mammoths and mastodons has led to the conclusion in some quarters that the latter animals were the more abundant by far, and the accompanying maps of distribution by counties as well as the actual numerical record would seem to justify this conclusion. However, there is another side of the question that has generally been overlooked. In the first place, it seems reasonable to assume that a much larger proportion of mastodons was preserved than that of mammoths because of the tendency of the former to frequent areas of natural swamp traps that offered vegetation more in keeping with their food habits. Furthermore, starting with the assumption that there were more mastodons in Missouri, it is reasonably certain that many mammoth bones have been incorrectly identified as mastodon. When the characteristic teeth are not found, the bones of the two are likely to be confused. A reasonable estimate suggests that about one-fifth of the finds identified as mastodon may represent mammoths.

In addition to the common mammoth described above, there were two other elephants that may have inhabited Missouri during the Ice Age. One of these *Mammuthus (Parelephas) columbi,* has been identified in several different locations in the state, as follows: Jasper County (MGSQV-1009), Benton County (MGSQV-1006) (MGSQV-1013), Atchison County (MGSQV-1036), Hickory County (MGSQV-1001), New Madrid County (MGSQV-1003), and Jackson County (MGSQV-1035). This elephant was somewhat larger than the average Indian elephant and had a tooth pattern that is distinctive.

Another form, *Mammuthus (Archidiskodon) imperator,* has not been reported in Missouri, although it is recorded in Iowa and Kansas. The normal range was farther to the southwest. This was a giant elephant that stood as much as 13 feet at the shoulder. In addition, it had a distinctive tooth pattern.

Although the pattern of the grinding surface in mature elephants of these three kinds differ conspicuously, it is difficult in some cases of single teeth to determine the identity with certainty. No attempt is made here to evaluate identifications that were made in the past, and subsequent finds are most commonly listed only as "elephant" or as "mammoth".

It is not known whether either or both of the latter two elephants had a hairy coat, but the normal more southern range of the "Imperial Elephant" suggests that this form at least did not have hair.

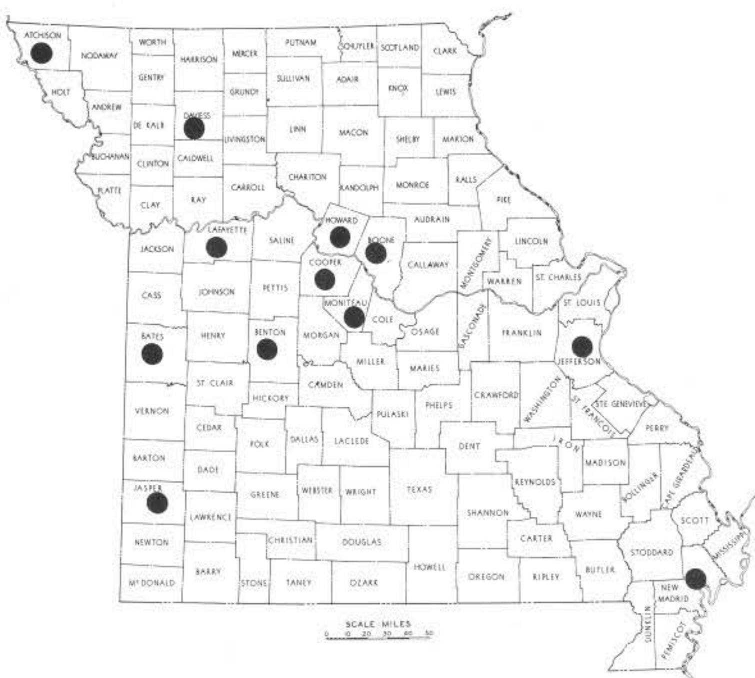


Fig. 20. Distribution of Pleistocene elephant finds in Missouri by counties. A single dot may represent several finds.

THE MASTODONS

FAMILY—MAMMUTIDAE; GENUS—*Mammut*

SPECIES—*Mammut americanus*

During the Pleistocene the mastodons rivaled in number the mammoths in Missouri. The term *mastodon* is derived from the Greek words *mastos (breast)* and *odon* (tooth). It describes the laterally paired conical protuberances on the crown of the tooth that is characteristic of this group, as was pointed out earlier. All of the many mastodon remains that have been found in Missouri probably should be referred to the species *Mammut americanus*. The printing of this name as it appears here is not an error on the part of the proofreader—it is the rule that the second part of a specific name is not capitalized although it may be a proper name like Jones!

Other than the differences in the teeth and tusks, as indicated in the preceding discussion of the mammoths, there is little in the skeleton of the mastodon that is useful to the beginner for field identification of mastodon and mammoth. Occasionally there is found the lower jaw of a young mastodon that bears one or two deciduous tusks, short, and of small diameter. The lower jaw of the mastodon is longer, and the forehead lower than in the mammoth. The two probably averaged about the same size, but the mastodon did not stand as high at the shoulder and in general was more stockily built. The shoulder blade (scapula) of the two differed appreciably, that of the mastodon being considerably wider, as shown in Figure 21. An obscure record indicates that hair had been found associated with mastodon bones, and this animal is commonly depicted with a shaggy coat, perhaps without sufficient evidence.

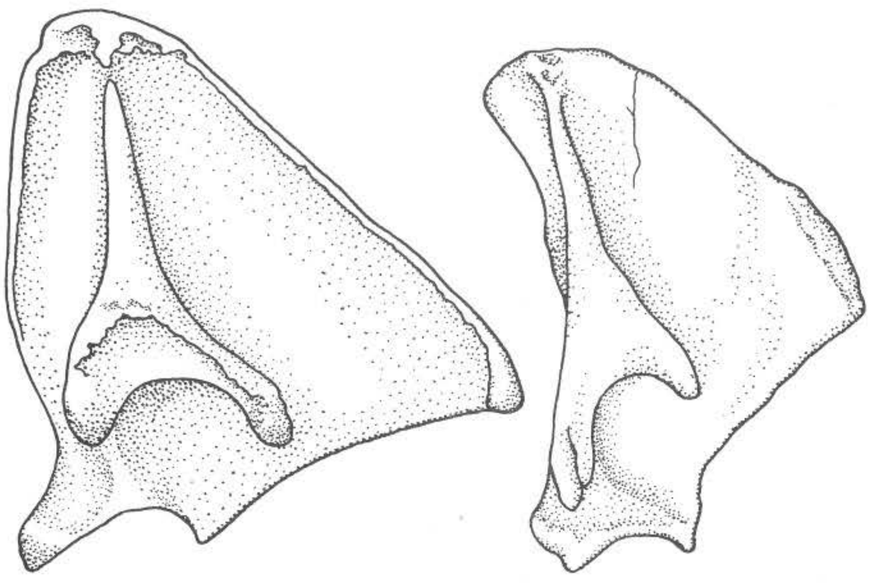


Fig. 21. Comparison of proboscidian scapulae. From left to right, left lateral view of mastodon and elephant, approximately; x ⅛.

Because of their coarse vegetation food habits, it is likely that the greater number of mastodon finds in Missouri is not a true index of the relative numbers of the mastodons and mammoths. As is discussed in later paragraphs, it is also likely that because of their food habits, the mastodons were more vulnerable to the attacks by the early Indians in Missouri than were the mammoths.

Man and mastodon in Missouri.—

Ten thousand moons ago, when nothing but gloomy forests covered this land of the sleeping sun,—long before the pale man, with thunder and fire at his command rushed on the wings of the wind to ruin this garden of nature,—a race of animals were in being, huge as the frowning precipice, cruel as the bloody panther, swift as the descending eagle, and terrible as the angel of night. The pine crushed beneath their feet and the lakes shrunk when they slaked their thirst; the forceful javelin in vain was hurled, and the barbed arrows fell harmlessly from their sides. Forests were laid waste at a meal and villages inhabited by man were destroyed in a moment. The cry of universal distress reached even to the regions of peace in the west; when the good spirit intervened to save the unhappy; his forked lightnings gleamed all around, while the loudest thunder rocked the globe; the bolts of heaven were hurled on the cruel destroyers alone, and the mountains echoed with the bellowings of death; all were killed except one male, the fiercest of the race and him even the artillery of the skies assailed in vain; he mounts the bluest summit that shades the sources of the Monongahela, and roaring aloud, bids defiance to every vengeance; the red lightning that scorched the lofty fir, and rived the knotty oak, glanced only on this enraged monster, till at length, maddened with fury, he leaps over the waves of the west, and there reigns an uncontrolled monarch in the wilderness, in spite of Omnipotence.

Mr. Albrecht Koch, who reported the above legend of the Shawnee Indians in a little pamphlet describing mastodon finds from Missouri in 1843, seems to have had a marked flair for embellishing the ordinary. It does not seem likely that the Indians thought of the earth as a "globe". One cannot be sure how much the legend was changed in retelling through countless generations and how much may have been contributed by Mr. Koch. "Cruel as the bloody panther, swift as the descending eagle, and terrible as the angel of night", although scarcely compatible with "forests were laid waste at a meal", is no more incongruous than the assumption by some of the early collectors that the mastodons were water dwellers and by others that they devoured flesh and fed themselves with their forefeet. It is possible, and even likely, that the first Indians did hand down accounts of a great beast, and many have assumed that the starting point was fear in beholding mastodon or mammoth.

In the paragraphs that follow, the mastodon is selected as the symbol of all of the several kinds of now extinct large mammals in the Late Pleistocene of Missouri. The mastodon is a good representative of these forms, for he seems to have been among the most abundantly represented. He is about the only member of the group that provides direct evidence bearing on the contemporaneity with Man in this state. Furthermore, the mastodon, being comparatively slow, was most likely to have had his environment, imposed by food habits, turned against him by ancient hunters.

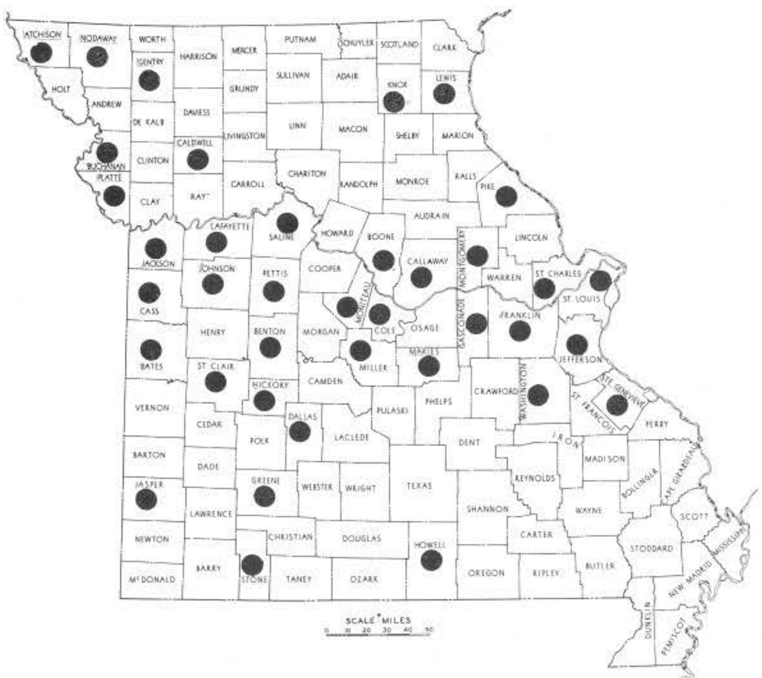


Fig. 22. Distribution of Pleistocene mastodon finds in Missouri by counties. One dot may represent several finds.

Who were the early men in Missouri?—All evidence points to the Indian and his ancestors as the only inhabitants of North America until relatively modern times. He is thought to have come to this continent along a land bridge where the Bering Strait now exists. A few bones of these migrants have been found, and in each instance the associated implements point toward these people as the ancestors of the American Indian.

When did the Indians reach Missouri?—The radio-carbon dating of the "Tepexpan Man" in Mexico, definitely an Indian, places his appearance between 11,000 and 16,000 years ago. Charcoal associated with implements not far from the "Richmond Mastodon" near Cromwell, Indiana, is dated as being about 5,300 years old and mastodon tusks in Washtenaw and Lenawee Counties, Michigan, are dated as being 6,000 and 9,568 years old respectively.

It is not likely that these early human inhabitants had reached areas in all directions around Missouri and yet did not enter this state. The meager evidence we have indicates that Missouri was also part of their very early range. On high terraces in western Missouri, points have been found that are thought to be characteristic of a complex to which the name *Nebo Hill* has been given. Their resemblance to those of the Guliford complex, which has been dated about —6,000, is very close. In Cole County, near Dalton, have been found points called *Meserve* or *Dalton,* and similar points have been found in Graham Cave, Missouri, at an horizon dated —9,000± years. Sandia points, named from Sandia Cave in New Mexico, have been found in western and southeastern Missouri. This culture has not been satisfactorily dated but is thought by some to be as old or older than the Clovis points which have been variously estimated from about —8,000 to —10,000 years, and even more. Artifacts found in the Berlin Museum and labeled Gasconade County, Missouri,—materials apparently associated with the

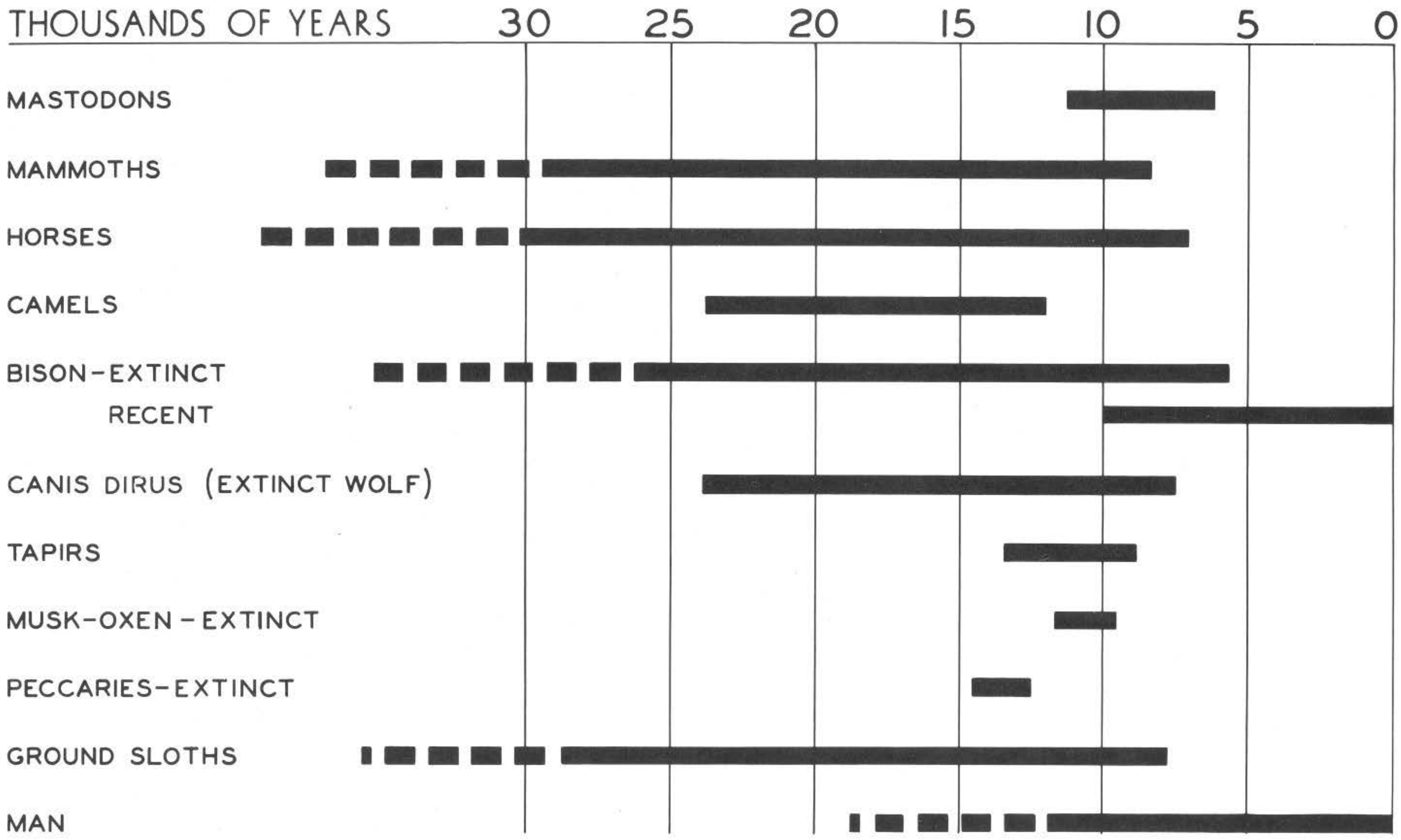


Fig. 23. Time range of some Pleistocene animals including Man. Solid lines indicate accepted C-14 dating. Broken line extensions indicate less satisfactory data. Chart compiled from data by J. H. Hester.

mastodon sold to the museum many years ago—are clearly not of the same age, but one seems to be a Dalton point.

Did early Missouri Indians see the mastodons?—Fortunately there has been sufficient acceptable dating of extinct Pleistocene mammals, including the Indians, so that we are not dependent on legendary accounts to find a satisfactory answer to this question. That Man and mastodon were contemporaneous seems established beyond reasonable doubt by the data presented in the accompanying chart (Fig. 23). However, while the opportunity to see is thus established, what the Indian did about it is an entirely different question. He may have seen and fled in terror, he may have just seen, or he may have seen and actually hunted the mastodon in some sense of the word. Our judgment of the behavior of the early Indians in Missouri may be less warped if first we examine activities of the first settlers in other parts of the country.

The Tepexpan Plain, flat land about the margin of an ancient lake, Texcoco, some 20 miles northeast of Mexico City, has contributed much to our knowledge of the first inhabitants of this continent. Over a period of years preceding the discovery here of the Tepexpan Man in 1947, there had been excavated more than a dozen skeletons of mammoth within a limited area. In 1952, there was discovered another skeleton, with intimately associated implements, close to the site of the early man. A second mammoth was found just south of the first in 1954. This find, Iztapan II, is the more important for it was the skeleton of a mature animal, *Mammuthus (Archidiskodon) imperator*, and was excavated by skilled scientists as carefully as would be an ancient human burial. The first specimen was a poorly preserved immature individual, and its cranium and some other parts had been destroyed by curiosity seekers before the scientists took over.

How these animals were killed is not evident, but that they were butchered by the Indians is a well founded conclusion. In each case, the skull was turned with the inferoposterior part upward, and the bone about this area was destroyed to give ready access to the brain. The vertebrae, ribs, and legs (with one exception) were disarticulated, and many of the bones show the marks of the chipping involved in this. There is no evidence of roasting fires on the spot, and this, coupled with the fact that some parts of the legs were missing, indicated that the flesh was consumed elsewhere.

Another butchering ground of the early Indians is the Lehner site in Cochise County, southeast Arizona, about 12 miles west of Bisbee and only a few miles north of the Mexico border. The report on this site by Haury, Sayles, and Wasley, in 1959, describes the slaughter of at least nine mammoths, *Mammuthus (Parelephas) columbi,* within an area probably not more than a few hundred square yards. The actual producing area today is much less. It is clear that the "kill area" was a seasonal water hole in the sharp bend of an ancient arroyo where small herds occasionally came to drink and wallow. The bones, very poorly preserved, represent only immature animals. There were no skulls identifiable as such, and the count was based on lower jaws. It seems likely that the skulls were destroyed here or elsewhere to salvage the brain. All parts were disassociated but not widely scattered. Thirteen projectile points, intimately associated with but not actually in the bone, may indicate how the young animals may have been killed. It seems likely that a young animal was selected from the wallowing herd and segregated from the stampeded animals as they fled along the limited access path to the water hole. Two small hearths, nearby on the "slaughter floor", date the site at between —11,000 and —12,000 years, and also suggest that dainty morsels may have been consumed on the spot by the hungry hunters. The kills obviously extended over an appreciable period of time.

Did the Missouri Indians hunt mastodons?—For the answer to this question, most investigators have turned to the ac-

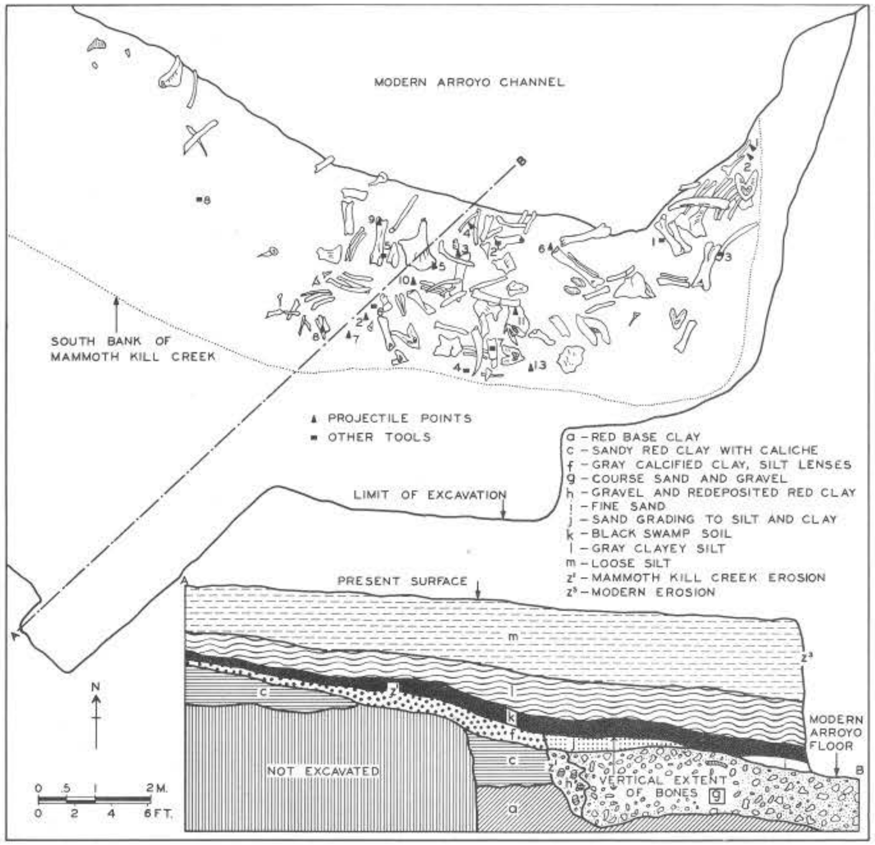


Fig. 24. (Above) The Lehner mastodon site, southwestern Arizona. Ground plan and cross section detail from Haury, Emil W., et al.

(Opposite page) Elephant "butchering ground." Partially excavated skeleton near Cooperton, Kiowa County, Oklahoma. The base of the skull had been battered in and several "long bones" cracked with a small rounded boulder. The excavation was made under the direction of Adrian Anderson of the Museum of the Great Plains at Lawton. The network of reference wires indicates the care with which the archaeologist works. Photograph through the courtesy of Marvin E. Tong, director of the museum.

counts of Albrecht Koch's discovery of a partly burned mastodon skeleton near the Bourbeuse River in Gasconade County in 1838. Hugo Gross, a German scholar, reported in 1951 that he had located in the Berlin Museum some of the mastodon bones that Koch had sold to the museum more than 100 years before. With the bones, Gross found several points that he believed were those claimed by Koch to have been found upon and within the ashes of the partly burned skeleton. Four of these were labeled "Missouri, Koch" and represent a type associated with the "Archaic Culture" in Missouri. Another point found in the museum and labeled "Gasconade County, Missouri" is considered a good illustration of the Dalton point, a type that has been dated at 7850 B.C. ±500 years.

This probably should be considered fair evidence that the Missouri Indian had the opportunity to see, but not necessarily the tact nor even the desire to kill. Gross does not follow what seems to be the popular trend, but chooses to interpret the available data as the discovery of a skeleton exposed by a freshet. This the Indians attempted to destroy for reasons of superstition, by burning. They completed the ceremony by tossing rocks and other objects into the fire.

At best, many questions are left unanswered. Why, for instance, should the skeleton be so burned that "it crumbled at the slightest touch" if the fire was for the purpose of preparing food, and why should the choicest morsel, the brain, have been so obviously ignored? The brain case was not broken open.

Why so few records of Man-mastodon association in Missouri?—During our discussions of mutual interest problems, Dr. Carl Chapman has called to my attention the fact that at this early period the Indian population of Missouri was small in comparison with even some of our smaller cities of today—possibly a total of 10,000 at any one time would be an overly generous estimate. Imagine the population of Rolla, for instance, divided into bands ranging from 50 to 100 each and distributed evenly over the state. The quota of each of the 114 counties would be one band of average size. If these people were big game hunters, they had to follow the animal or herd on foot and be on the move most of the time. It is not likely that they lost implements with every kill, and it is certain that not every skeleton that is found was killed by these men. Of the relatively small proportion of sites that have escaped the ravages of time, only a very few have been found because there has never been instituted a systematic search. The great majority of finds have been made by persons unfamiliar with the techniques required to accumulate and record all the data needed for proper interpretation. Almost without exception, when mastodon and similar bones have been found, those that were exposed already or uncovered by crude excavation have been gathered indiscriminately without regard to important evidence that might have been readily available.

THE EDENTATES

(ORDER EDENTATA: SLOTHS, ARMADILLOS, ANTEATERS)

Most of the representatives of this order are vegetation eating, claw-bearing animals that have a body covering of hair, horny scales, or bony scutes. Although the group name Edentata (Latin: *e-* out of+ *dentis*-teeth) suggests that these mammals have no teeth, this is true of only some of the members. However, among the tooth-bearing representatives, the teeth are almost unique. They are more or less peglike with open roots (hence, constant growing) and are not capped by enamel.

The Missouri Pleistocene record of the edentates includes two distinct divisions, the ground sloths and the armadillos.

GROUND SLOTHS

Of the three families of ground sloths known from the Pleistocene in North America, only two are identified with certainty among Missouri finds—the Megalonychidae and Mylodontidae. The third, Megatheriidae, was identified by Richard Harlan in 1843 at the Pomme de Terre River locality (MGSQV-1001) but the identification was made from very fragmentary material that was subsequently lost. The record is generally questioned because this sloth, the largest of the three "big as an elephant", seems to have a more southern range than the others.

FAMILY—MEGALONYCHIDAE; GENUS—*Megalonyx*

SPECIES—*Megalonyx jeffersoni*

Among those who are well versed in American History and in the life of the "Father of the Declaration of Independence", it may come as a surprise to many that Thomas Jefferson was a naturalist of considerable ability. It was President Jefferson who described claws and other bones of a previously unknown animal and suggested that it be called "*Megalonyx*" (Greek: *megal* big + *onyx* claw). Later, this species was named *Megalonyx jeffersoni* in his honor.

This is not an exceptionally large sloth, probably little more than 5 feet at the shoulder and a total length of about 12 feet. Presumably descendants of tree dwellers, hanging up-side-down, they retained the long curved claws after they became strictly ground living. This gave them a slow and very awkward gait as they walked on the outer edge of the feet with the claws turned in and upward. Instead of degenerating as would be expected, the claws proved useful in pulling down tree branches that could be reached by rising to the haunches. It is possible that the claws of the powerful hind feet were utilized for tearing up roots.

This group of sloths fed on coarse vegetation such as might be expected in swampy areas, and it is not uncommon to find their remains associated with those of mastodons. The accompanying map showing the known distribution of all sloths in Missouri suggests that their range was more limited than that of the proboscidians.

Fig. 25. Distribution of ground sloth finds in Missouri by counties. A single dot may represent several finds.

FAMILY—MYLODONTIDAE; GENUS—*Mylodon*

SPECIES—*Mylodon harlani*

Although this genus and species has been identified from the Pleistocene of Missouri, it is difficult to check on old records, and it is probably well not to distinguish here between the Mylodont and the Megalonychid sloths. The former were somewhat smaller than the Megalonychids and seem to have depended more on coarse grasses for food.

ARMADILLOS

FAMILY—DASYPODIDAE; Genus—*Dasypus*

SPECIES—*Dasypus bellus*

The second distinctive group or suborder of edentates found in the Pleistocene of Missouri, the armadillos, is represented by a single record reported by Simpson from Cherokee Cave in St. Louis County (MGSQV-1071). The remains represent the common species of the present day southwestern part of the United States and farther south.

It is well to remind ourselves again that the number of fossil specimens found is not always a true indication of the abundance of a particular kind of animal. It is not conceivable that the armadillos were very few in number during the Pleistocene or that they were confined to one small area in Missouri. These are burrowing creatures that are vulnerable to nature's special traps or other accumulators of skeletons.

THE PERISSODACTYLS

(ORDER PERISSODACTYLA: HORSES, TAPIRS, ETC.)

Among hoofed mammals that bear their weight on the middle toe (odd-toed, hoofed mammals) the closely related living forms are the horse, tapir, and rhinoceras. (A more detailed distinction between odd- and even-toed animals is to be found in the section on the vertebrate skeleton.) There are many remains of horses in the Pleistocene of Missouri, but as indicated below, there is but a very limited record of tapirs, and no remains of the rhinoceras group have been found.

HORSES

FAMILY—EQUIDAE; GENUS—*Equus*

SPECIES—*Equus complicatus*

An examination of the records of Missouri's Ice Age horses discloses that more reports of finds are received today in a given time than was the case a few decades ago. When one considers the fact that most such records come from rural districts, a plausable explanation is evident. Although horse teeth are among the most easily identified vertebrate fossils, so completely has the horse been replaced on the farms by machinery that few young people know the details of horse dentition. There was a time when every farm boy could determine fairly accurately the age of a horse by examining its teeth, and to him a horse tooth was no curiosity. In consequence, it is likely that in earlier days, many Pleistocene horse teeth were ignored, whereas, today they are real curiosities. This is another illustration of the benefits from progress—in this case benefit to the paleontologist!

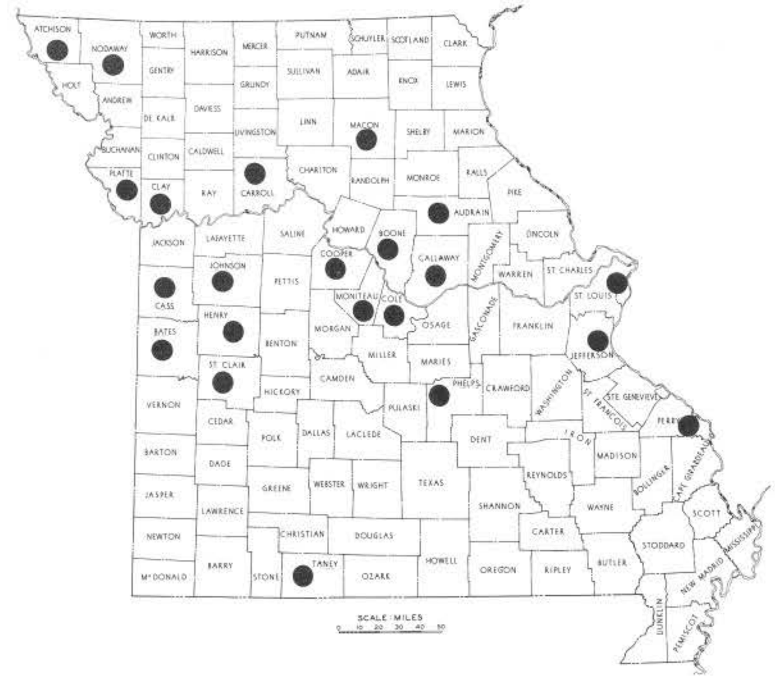


Fig. 26. Distribution of Pleistocene horse remains in Missouri by counties. A single dot may represent several finds.

Pleistocene horses have been found in about a third of the counties in Missouri. Most of these records are of teeth, but in a few cases scattered bones in a limited area represent all parts of the skeleton. An outstanding illustration of this is the locality in Moniteau County described as the Enon Sink (MGSQV-1063). Here parts of skulls, several lower jaws, numerous isolated teeth, and many leg bones indicate the trapping of several horses, most of them comparatively young.

Several species have been reported from various parts of Missouri, but it is difficult to distinguish one from the other from fragmentary material. The teeth of all resemble very closely (to the nonspecialist, at least) those of the domestic animal. Before much can be done toward specifically identifying all of the finds, a thorough study of many specimens will be necessary. If a technical name seems desirable, no specimen departs markedly from what has been called *Equus complicatus*. One specimen in the University of Missouri collections (V.P. 658), consisting of all the teeth, part of the skull, and the lower jaw, resembles the typical Missouri mule. It is possible that the asses, *Equus asinus*, were present in Missouri during the Pleistocene. It is also possible that the specimen is of recent time although said to have come from beneath a cover of 19 feet of loess.

The common Pleistocene horse of Missouri was a grass-eating, plains-dweller, with slender legs and small hoofs. It was a small horse, probably averaging somewhat larger than one of the larger Shetland ponies. Its head gives the appearance of being too large for the body. It probably resembled closely *Equus przewalski*, the wild horse of the Steppes of Russia.

TAPIRS

FAMILY—TAPIRIDAE; GENUS—*Tapirus*

SPECIES—*Tapirus excelsus*

A tapir, *Tapirus excelsus*, constitutes one of the most interesting of Missouri's Ice Age vertebrate records. In the first place, the bones, representing one nearly complete skeleton and lesser parts of several more individuals, are perhaps the best among the many that have been found in various parts of the United States. The skeleton represents a new species, unreported from any other place in the world. The bones were found in a single locality in Moniteau County, described elsewhere as the Enon Sink (MGSQV-1063). Not only is this the best Missouri record, but one of a very few in North America that lies close to the margin of the most extensive ice invasion of the Pleistocene Period. A single tooth of another genus, *Tapirella*, was found at Herculaneum (MGSQV-1102) in Jefferson County.

The tapir race is one of nature's enigmas; they are today almost as primitive as at their inception many millions of years ago. They live in three widely separated areas: Central America and tropical South America, Borneo, and the Malay Peninsula. They have always been forest dwellers that feed on coarse vegetation. Their teeth resemble closely, in miniature, those of the mastodon. The tapir race has never produced giant representatives. The largest probably had a body length of about 5 feet and stood not more than 3 feet at the shoulder. This was the size of *Tapirus excelsus*, the Enon tapir. They all had barrel-like bodies and moderately stout legs. Today they have a sleek coat of short thick hair. Most of the weight of the animal is supported by pads just behind the hoofs that terminate each toe, four in front and three behind. One of the most striking features of this strange animal is its short trunk or flexible proboscis.

THE ARTIODACTYLS

(ORDER ARTIODACTYLA: SWINE, CAMELS, DEER, OXEN, ETC.)

Regardless of differences in size, shape, and habits among the artiodactyls (even-toed, hoofed mammals), this group can be distinguished most readily from the perissodactyls (odd-toed, hoofed mammals) by comparing the tooth pattern and foot structure of a cow and a horse, typical representatives of these two groups respectively. If we think of the hoof as the part of the foot that supports the weight of the animal, the cow has a cloven or split hoof. That is, the weight comes between two toes. On the other hand, the weight of the horse is borne by a single toe. As is indicated in a later discussion on anatomical terms, the number of toes on the foot is not important; it is the distribution of the weight on the palm- and the arch-bones.

Not all, but several of the groups that make up the artiodactyls, are ruminants, or "cud chewers", a development that goes with a complex stomach that is not found in the Perissodactyls. The teeth of the Artiodactyls are anteroposteriorly directed, crescentic ridges so that the jaw swings sidewise for efficient trituration of the food.

Although artiodactyls are of a great variety and are very abundant all over the world today and during the Pleistocene, the Missouri fossil record is comparatively meager and not of great variety. The most abundant representation is the peccaries, a piglike group.

CATTLE

FAMILY—BOVIDAE; GENUS—*Bison*

SPECIES—*Bison bison* (AMERICAN "BUFFALO")

The 12 or more finds of bison reported from the Pleistocene of Missouri are scattered over as many counties without evidence of limited range or special environmental trapping. All but a few of the remains are to be referred to the present day species, *Bison bison*. Bison teeth resemble those of the domestic cattle so closely that it is likely many kinds of Pleistocene bison have been ignored.

These animals were grazing creatures dependent largely on grasses of the open areas rather than forests. The early Indians of Missouri probably were less dependent on the bisons for food than were the plains people.

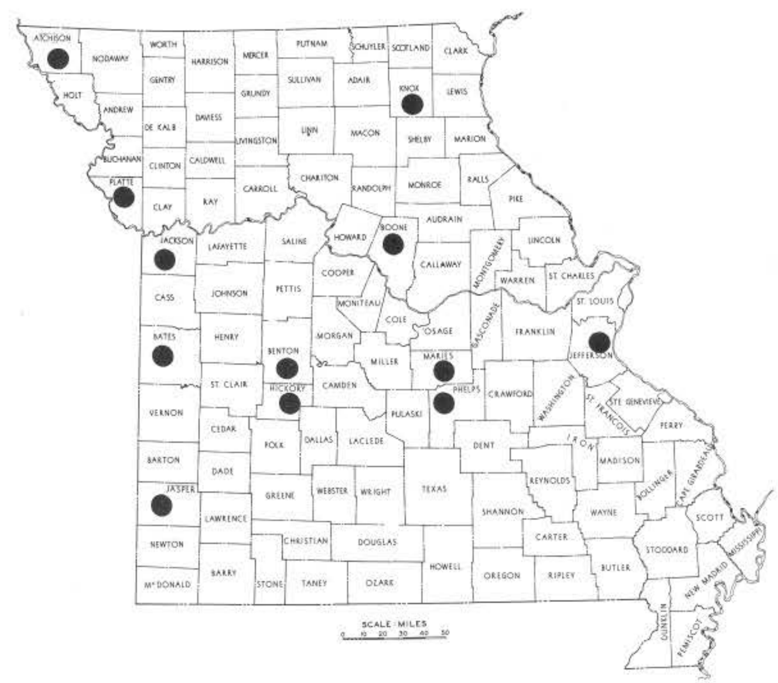


Fig. 27. Distribution of Pleistocene bison remains in Missouri by counties. A single dot may represent more than one find.

There were several kinds of bison living in the area of the central states during the Pleistocene, all now extinct except *Bison bison,* listed above. The identification of these extinct species from fragmentary remains is difficult, but part of a skull in Atchison County (MGSQV-1073) probably should be referred to *Bison occidentalis.* Possibly some of the other records represent extinct species.

FAMILY—BOVIDAE; GENUS—*Symbos*

SPECIES—*Symbos cavifrons* (MUSK-OX)

The only other representatives of the cattle group in the Pleistocene of Missouri, the musk-oxen, do not seem to have been abundant. *Symbos cavifrons* is the most commonly found species in the Pleistocene of the Central United States and the only form that is identified with certainty in Missouri. It has been recorded from Benton, Cape Girardeau, Cooper, Iron, Jefferson, New Madrid, and St. Louis Counties—one find in each, except in Benton County where parts of three individuals were found. The specimen from Cape Girardeau County, the posterior part of a skull with base of horn cores, is in the Univeristy of Missouri collection. The specimen figured by Holmes (1949, Fig. 225) is in the private collection of Mr. Widel at Blackwater, Missouri.

This animal was about the size of average representatives of the present day species. One of the chief apparent differences is in the horns. In Missouri's Ice Age specimens, the horn base did not reach the midline of the skull, was directed more laterally and downward, and the horn was probably longer. Presumably the body covering was much the same. Both had excellent grinding teeth, comparable to those of the bison and cattle.

Today the musk-ox is represented by a single form, *Ovibos moschatus,* now confined to the most northern part of North America. During the Pleistocene, it ranged over northern Europe and Asia and was more widespread in North America than at present. This animal is comparatively small, about 6 feet in length and not more than 4 feet tall. It has a thick undercoat of wool-like hair and an outer coat of long straight hair. The horns curve down, then forward and upward toward the tip. They are broad and flattened at the base, meeting at the middle line of the skull. No representative of the present day

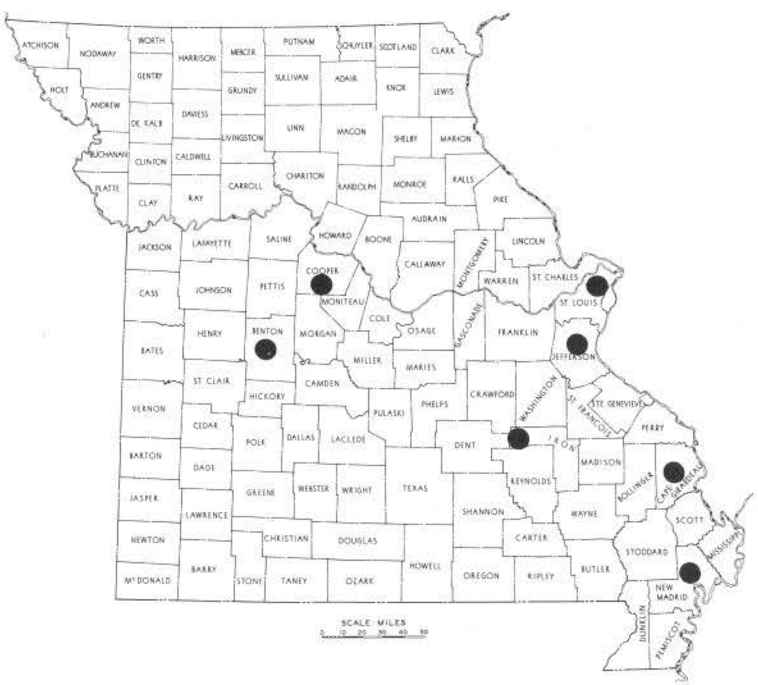


Fig. 28. Distribution of Pleistocene musk-ox remains in Missouri by counties. A single dot may represent more than one find.

species is found in the Missouri Pleistocene. There were several other genera of musk-oxen, now extinct, that were fairly widespread during the Pleistocene elsewhere.

DEER

(FAMILY—CERVIDAE)

It is likely that the early hunters of Missouri concentrated their efforts on the very abundant deer population. Where animal bones are found associated with these men in ancient shelters and camp sites, the proportion of deer bones averages very high. In the debris of an early shelter south of Bolivar in Polk County overlooking the Little Sac River, there was found a crypt burial of painted human skulls and "long bones", marking one of the oldest levels of habitation here. Over a period of several decades, curiosity seekers have discarded great quantities of bones and teeth as they have dug indiscriminately searching for points. In bulk at least, jaws and other skeletal parts of deer make up the majority.

In addition to the contribution of bones to the caves of Missouri by the Indians, the various carniverous predators in the past as today, dragged entire carcasses or parts of the kill in the tortuous passages of the caves, and with few exceptions deer remains are most abundant.

It is likely that most of the deer remains found in caves and stream gravels of the state are of recent age, but some of the remains are almost certainly to be dated as Pleistocene. It is obvious that the materials recorded from each site listed cannot in all cases be accepted safely as time associations. On the other hand, associations that are made up almost entirely of remains of extinct groups, such as locality (MGSQV-1073) in Atchison County, suggest strongly that the deer remains should be designated as Pleistocene.

FAMILY—CERVIDAE; GENUS—*Odocoileus*

SPECIES—*Odocoileus virginianus*

(VIRGINIA OR WHITE-TAILED DEER)

Remains identifiable as the Virginia deer are reported from the following MGSQV localities: Atchison (1073), Benton (1006), Hickory (1001), Jefferson (1005), Phelps (1084), Platte (1056), Pulaski, (1083), and St. Louis (1071) Counties.

FAMILY—CERVIDAE; GENUS—*Cervus*

SPECIES—*Cervus canadensis*

(WAPITI OR AMERICAN ELK)

The American elk has been identified tentatively in the following MGSQV localities: Atchison (1073), and Hickory (1001) Counties.

FAMILY—CERVIDAE; GENUS—*Alces*

SPECIES—*Alces americana* (AMERICAN MOOSE)

The extinct moose, *Cervalces,* has been identified tentatively from teeth and antlers found in Jefferson County (MGSQV-1005).

The genus *Rangifer*, the caribou, is found in the Pleistocene of Iowa but has not been reported from Missouri.

PIGS

(FAMILY—TAYASSUIDAE)

The only representatives of the piglike group in the Pleistocene of Missouri are the peccaries. These animals are, for the most part, smaller than the true swine as typified by the European wild boar *Sus scrofa*. Although the peccaries are more advanced in their teeth and other features, they are very piglike in general structure and appearance. In the swine, the upper tusks curve upward and outward to present formidable weapons extending considerably beyond the jaw. The canines of the peccaries are more nearly straight and are directed vertically. The molars have two pairs of conelike denticles laterally aligned so as to create essentially two transverse ridges on each tooth. In the swine, the protuberances are more numerous and varied and do not present a constant pattern.

FAMILY—TAYASSUIDAE; GENUS—*Platygonus*

SPECIES—*Platygonus compressus*

(PLEISTOCENE PECCARY)

The most common Pleistocene peccary, *Platygonus compressus,* was somewhat larger than the living *Tagassu tajacu* that today range no farther north than Arkansas. The Pleistocene peccaries had a wide range and were very abundant in Missouri. They were gregarious as is the living species, and where one was trapped it is likely that others of the little family group or entire herd would perish in the same manner. They were typically forest dwellers and piglike in habit. Remains have been reported from Benton, Cooper, Jefferson, Morgan, Platte, Pulaski, and St. Louis Counties. An exceptional find was that in the Cherokee Caverns (MGSQV-1071) where remains of many individuals were excavated by G. G. Simpson. Many bones of this species have come from Bat Cave [MGSQV-1083] in Pulaski County.

Fig. 29. Distribution of Pleistocene peccary remains in Missouri by counties. In most cases one dot represents more than one find.

CAMELS

(FAMILY—CAMELIDAE)

"Tylopod" (Greek: *tylo* knob + *pod* foot) describes a characteristic of the camel group well—two pads rather than the hoofs support the weight. This division includes the present day camels and llamas. The meager terminus of a lineage that is clearly traceable back to the upper Eocene of North America where a form the size of a jack rabbit fits well the requirements of progenator. Some very primitive artiodactyls found in the early Eocene may well belong in the direct line of descent.

Although nearly the entire story of cameloid development took place in North America, the only living representatives are two species of true camels in Asia and the llamas of South America. Strangly enough, the desert dwelling camels entered Asia by the far north route and the high altitude llamas traveled to South America by the southern route—both during the Pliocene. Both of these groups had disappeared from North America before the end of the Pleistocene.

Although there is a very distinctive tooth development that sets the camel group apart from other artiodactyls, the surest identification for the nonspecialist is found in the metapodials (see section on anatomical terms). Numbers 3 and 4 are united into a single bone such as in the cattle, except that at the distal end, they are separate and bent to form an inverted "V" shape. There are only two toes on each foot.

FAMILY—CAMELIDAE; GENUS—*Camelops*

SPECIES—*Camelops kansanus*

Only very fragmentary specimens of camels have been reported from the Pleistocene of Missouri. One large premolar tooth from Atchison County (MGSQV-1036) is referred doubtfully to *Camelops kansanus*.

FAMILY—CAMELIDAE; GENUS—*Tanupolama*

SPECIES—*Tanupolama parvus*

An upper molar tooth found in a crevice near Herculaneum in Jefferson County (MGSQV-1102) is referred to *Tanupolama parvus* by Olson (1940).

THE CARNIVORES

(ORDER CARNIVORA;

SUBORDER FISSIPEDA: CATS, DOGS, BEARS, ETC.)

As is to be expected, records of Ice Age carnivores (flesh eaters) are not abundant. In the first place in any economy, the flesh eaters are much less numerous than the herbivores (plant eaters) upon which they feed. Furthermore, they are not generally gregarious like the bison, horses, elephants, or peccaries, but lone hunters; hence, not likely to be preserved as fossils except singly. With few exceptions, the entire order is very meagerly represented in the Missouri Pleistocene.

CATS

FAMILY—FELIDAE; GENUS—*Felis*

SPECIES—*Felis concolor*

One felid which has been found in Missouri Pleistocene deposits and which can be identified with assurance is a single upper "slicing" tooth that has been referred to the species *Felis concolor*, the mountain lion or puma. The tooth was found in the Herculaneum crevice-fill mentioned above (MGSQV-1102).

Another large felid, considerably larger than the present day mountain lion is represented by well preserved foot prints found by Jack Reynolds in a cave in Perry County.

DOGS

FAMILY—CANIDAE; GENUS—*Canis*

SPECIES—*Canis dirus*

Two specimens of the large extinct dire wolf, *Canis dirus*, have been identified from the Missouri Pleistocene.

Three teeth in Walker Museum at the University of Chicago (No. 1736) are referred to this species. They come from the crevice-fill near Herculaneum in Jefferson County (MGSQV-1102). The second find, from Carroll Cave in Camden County [MGSQV-1079], has already been described. These remains include representative pieces from all parts of the skeleton including a nearly complete skull and jaws with full dentition. The specimen found by Dr. Hawksley is on loan to the University of Missouri and is registered in the collection at the Wild Life Laboratory.

Remains consisting of a few teeth and foot bones well preserved but fragmental found in a Pulaski County cave [MGSQV-1103] are identified by Hawksley and Meyers as *Canis dirus*. Gary Schevers and associates found foot bones of a large canid, possibly a young dire wolf, in the same cave.

Several foot bones of a wolf (American Museum of Natural History, No. 45732) larger than *Canis dirus* and differing from corresponding parts of the modern form, were found in Cherokee Caverns in St. Louis County (MGSQV-1071).

FAMILY—CANIDAE; GENUS—*Canis*

SPECIES—*Canis latrans*

The species *Canis latrans*, the extinct coyote, is represented by a single find in Jefferson County (MGSQV-1102). The find consists of a slicing tooth which is somewhat larger than the average of living representatives.

FAMILY—CANIDAE; GENUS—*Urocyon*

A lower pre-molar tooth from the Herculaneum crevice (MGSQV-1102) was identified by Olson (1940) as belonging to the genus *Urocyon*, the gray fox.

RACCOONS

FAMILY—PROCYONIDAE; GENUS—*Procyon*

SPECIES—*Procyon lotor*

All known Missouri Pleistocene raccoon remains are to be referred to the present day species of American raccoon, *Procyon lotor*. Under these circumstances, it is not always possible to state positively that a given find is from the Pleistocene. Remains of undoubted Pleistocene age are recorded from the Herculaneum crevice (MGSQV-1102) and the Cherokee Caverns (MGSQV-1071). I have identified Pleistocene remains with some assurance from Granny Baker Cave in Phelps County (MGSQV-1084) and from Schneider's Cave (MGSQV-1089). Today the raccoon is a great traveler, and his footprints may be expected far back in almost any stream-marked cave. It is likely that his Pleistocene forbearers had comparable habits. Most of the Pleistocene remains indicate animals slightly larger than the average of this species today.

BEARS

FAMILY—URSIDAE; GENUS—*Arctotherium?*

One of the most interesting of Missouri's Pleistocene vertebrate finds is the record of a short-faced bear, *Arctotherium?*

Fig. 30. Head of Pleistocene giant short-faced bear. From Merriam and Stock.

sp. The material consists of a complete humerus (upper arm bone) found in Carroll Cave in Camden County [MGSQV-1079] as described earlier. This represents a group of huge bears that were diversified and abundant in South America during the Pleistocene but only sparsely represented in North America. Several records are found in the Yukon and in California, and a single specimen has been found in a cave in Pennsylvania. The Missouri specimen, probably a new species of the genus, is the first record in the heart of North America. It is recorded in the University of Missouri collection as V. P. 682. Two other records, both consisting of foot bone and one or more fangs (MGSQV-1103 and -1104) are referred to the giant cave bear group and indicate more than one species in the Missouri Pleistocene.

FAMILY—URSIDAE; GENUS—*Ursus*

SPECIES—*Ursus americanus*

All of the many specimens from several other cave localities probably are to be referred to the present day black bear, *Ursus americanus*. Material from Cherokee Caverns of St. Louis County (MGSQV-1071) includes part of a jaw with one tooth and several separate teeth. From a cavern in Boone County [MGSQV-1093], skeleton material representing a dozen or more individual bears of this species has been collected by Professor Elder of the University of Missouri. In a deep solution funnel in Laclede County [MGSQV-1091], a large number of bones of this species has been found by Dr. Hawksley and associates. The bears from this locality average somewhat larger than those from the other two localities.

In several of Missouri's commercial caves, such as Onondaga Cave in Crawford County and Round Spring Caverns in Shannon County, bones of bears (presumably *Ursus americanus*) are on display. Some of these may represent Pleistocene occurrences. An exceptionally interesting occurrence of a definitely recent black bear is represented by three or more complete skeletons in Bat Cave in Shannon County. One skeleton, almost completely covered with calcium carbonate or cave deposit included a perfect "willow leaf" (Nodena) point, suggesting an age not greater than several hundred years.

SMALL MAMMALS

There can be little doubt but that the smaller mammals like the squirrels, gophers, ground squirrels, rabbits, and ground hogs were as abundant in Missouri during the Pleistocene as today, but there are very few finds of Pleistocene representatives. Possibly many have been overlooked because in most cases they are the same as living species and do not look old.

Actual records of small mammals in the Pleistocene seem confined at the present to very few localities. Most important of these is Cherokee Caverns in St. Louis County (MGSQV-1071) and the Herculaneum crevice in Jefferson County (MGSQV-1102). At the first locality, there were found the skull and two jaw rami of a ground hog, *Marmota monax;* a chipmunk, *Tamias striatus;* and a pocket gopher, *Geomys bursarius.* At the second locality, were found a variety of rodents including the following:

1. *Lepus americanus,* the common rabbit
2. *Sylvilagus (Limnolagus) aquaticus,* the swamp rabbit
3. *Sciurus sp.,* a small squirrel
4. *Peromyscus muttalli,* the white-footed mouse
5. *Nutoma pennsylvanica,* the wood rat
6. *Microtus sp.,* "voles" or field mice

THE REPTILES

Of the five groups of living reptiles, crocodiles, turtles, snakes, and lizards, are represented in North America today and were living here during the Pleistocene. The fifth group, the Rhynchocephalia, has a single living representative, the lizard-like *Sphenodon* which is confined to New Zealand.

(ORDER CROCODILA: CROCODILES, ALLIGATORS, ETC.)

Two supposed Ice Age crocodilians have been found in Missouri. Many years ago (about 1919), there appeared in the window of a drug store in Columbia part of a lower jaw said to have been found in a local cave. It was labeled "pig jaw" but was clearly a crocodilian, probably a species of *Alligator.* There is no record of the disposal of this specimen.

The second find of a crocodilian, which is of undoubted Pleistocene age, consists of several bony scutes from the back of a reptile representing the genus *Alligator;* probably the present day species *Alligator mississippiensis.* The scutes were found in the Herculaneum crevice (MGSQV-1102) and are now in the Walker Museum at the University of Chicago.

(ORDER CHELONIA: TURTLES)

Turtle remains have been found in the Herculaneum crevice (MGSQV-1102) and the Enon Sink (MGSQV-1063). Lesser records are found in Franklin County (MGSQV-1085), Jasper County (MGSQV-1009), and Perry County (MGSQV-1105). In all cases except in the Enon Sink and in the cave in Franklin County, the remains were too fragmentary to be more closely identified.

It is said that during the excavation of the Enon Sink several complete turtle shells were carried away by curiosity seekers, and many were broken in the normal process of excavation. One perfect skull in the University of Missouri collections (V.P. 685), a complete carapace (back shell) of a large box turtle (University of Missouri, V.P. 683), and a complete shell (carapace and plastron) from a terrapin of moderate size (University of Missouri, V.P. 684), come from this locality.

From a cave in Franklin County (MGSQV-1085) came a fairly complete shell of an exceptionally large box-turtle that probably represents a new genus. This was found in a small pebble chert conglomerate which is cemented by calcium carbonate and almost completely covered by drip stone. The specimen is at Central Missouri State College at Warrensburg.

A small part of the plastron of a large box-turtle was found in a cave in Perry County (MGSQV-1105) by Ronald Oesch.

(ORDER SQUAMATA: SNAKES)

In the Herculaneum pit (MGSQV-1102) were found a large number of vertebrae thought to represent a species of "rattlesnake", *Crotalus*. In the Calloway County fissure (MGSQV-1086), many snake vertebrae and ribs along with a fair number of the typical rattlesnake fangs have been found.

Two genera of the family Colubridae are thought to be represented by snake remains in the Herculaneum fissure, *Coluber* (perhaps a black snake) and *Elaphae*, another nonpoisonous group. In Perry County (MGSQV-1105) was found a connected series of many small snake vertebrae, all thoroughly mineralized and embedded in a mass of travertine.

(ORDER LACERTILIA: LIZARDS)

The jaws of a small lizard were found in the Callaway County crevice (MGSQV-1086).

WHAT ABOUT THE DINOSAURS?

Through such media as the story book, plastic models, billboard advertising, and horror spectaculars, many youngsters—and their elders, too—have become acquainted with dinosaurs to the extent that the terms *dinosaur* and *fossil animal* are almost synonomous in the thinking of many people. If, in these pages one finds disappointment because of the discussion of elephants, tapirs, camels, horses, and pigs to the exclusion of dinosaurs, he should again remind himself that the latter are products of the *Age of Reptiles* and that the Pleistocene animals represent the "last few seconds" of the *Age of Mammals*. Even so, in deference to the general interest, the time gap might have been ignored in the present account had Nature been less parsimonious in recording the events of the Mesozoic Era as they occurred in Missouri. Although it is certain that dinosaurs, and other bizarre reptiles of that time, found Missouri much to their liking there are practically no deposits in the state in which their remains might have been preserved. Almost from the appearance of the first primitive reptiles on the earth throughout the countless millions of years that followed till a few seconds ago (geologically speaking), Missouri suffered more from erosion than was repaired by deposition. However, there are a few exceptions to this general rule of lack of recording media during this lost interval.

During the latter part of the Mesozoic Era (the Cretaceous Period), the Gulf Coast embayment extended well up into what is now the Mississippi Valley. Several patches of deposits formed in this sea are to be found in Stoddard and Scott Counties of Missouri. Unfortunately, no reptile remains have been found in these Cretaceous sediments. Even part of the skull of the porpoise-shaped, marine reptile, *Ichthyosaurus*, credited to Missouri by early writers, was found near the junction of the Yellowstone River with the Missouri River—not in the state of Missouri.

The single record of a Mesozoic reptile in Missouri came from land deposits of about the same age as the marine invasion but in Bollinger County, and this was a dinosaur! Early in the Spring of 1942, a well was dug on the farm of Mrs. Lulu Chronister (Center sec. 26, T. 31 N., R. 9 E.) not far from Lutesville. Millions of years ago a long depression formed by the downfaulting of Ordovician limestone was filled with Cretaceous nonmarine clay. The well dug into this clay disclosed a string of a dozen or more vertebrae from the tail of a comparatively small representative of the group to which *Diplodocus* belongs.

Mr. Dan R. Stewart, at the time a geologist on the staff of the Missouri Geological Survey, and Mr. Charles W. Gilmore* described these remains in 1945 under the name *Neosaurus missouriensis* (Gilmore and Stewart, 1945). The bones are in the Smithsonian Institute at Washington.

*Charles W. Gilmore (1874-1945) was Curator of Vertebrate Paleontology, U. S. National Museum, Washington, D. C. from 1923 to 1945. He specialized in the study of Mesozoic reptiles.

THE BIRDS

Almost nothing is known about the avian fauna of Missouri Pleistocene. This is not strange, for throughout their history the birds have left the most fragmentary record of all the vertebrates, excepting perhaps the monkeys, apes, and Man.

Excluding the doubtful Pleistocene age records of bone implements associated with early Indian cultures, only one bird bone from Missouri Ice Age has come to my attention. At locality MGSQV-1073 in Atchison County was found the shaft of a tibia-tarsus (the lower part of the leg) from a bird the size of the great blue heron. This was associated with bones of mastodon, mammoth, sloth, bison, elk, and deer under circumstances that suggest camp refuse rather than natural association.

THE PLEISTOCENE VERTEBRATE RECORD IN RETROSPECT

Perhaps the first reaction of the average reader of these pages which list discoveries of Pleistocene vertebrate animals in Missouri, is a feeling of pleasant surprise—surprise at the large number of finds and the considerable variety that they represent. Reviewing the variety of situations that account for the preservation of these animals, the reader must recognize that Missouri is not equaled by many other states in distribution of recording media. For instance, how many others were half ice-free and half dotted by many hundreds of Pleistocene caves and shelters? What other states had a wide belt of swamp area to record both arctic faunas and the life of the plains and forests at the same time? Where else could one find such a large number of channels choked by sand and gravel contributed by floods resulting from the melting ice margin?

Possibly the first reaction is followed by surprise at how relatively little has been accomplished in deciphering our Pleistocene animal record. What a small part of our total number of cavern possibilities, for instance, have been investigated! Although bones representing dozens of mastodons have been dug from swamps, actually only one, the Kimmswick trap has been thoroughly investigated with modern methods. It is clear that the Vienna and Sedalia swamps and even the ancient hunting grounds of Albrecht Koch still have much to offer. Other swamp areas are known but as yet have not been investigated for skeletal remains. No one can doubt that the passages of a single cavern, the one in Camden County that gave us the fine record of the dire-wolf and the short-faced bear, have scarcely been touched. In its 5 to 8 miles of tortuous passages, much of it floored by a thick deposit of clay, silt, and gravel, only bones that were almost unavoidable along the easiest path have been reported. From a record of little more than 200 Missouri caves before 1956, the number of known caves in the state has increased to well over 1,000 early in 1961 and is increasing rapidly!

The fields of exploration in Missouri are almost limitless and will not be overcrowded by searchers regardless of the numbers that succumb to the natural appeal of exploration. It is a fascinating and rewarding task for the very many.

For every thrilling find, there is sure to be many a disappointment, but to the dyed-in-the-wool collector, this is taken for granted. The State Geological Survey wishes to assist in every way possible but can do little more than help coordinate your efforts, record your finds, and advise in making identification.

EXTINCTIONS

Before the white men reached North America, many kinds of animals that were conspicuous during most of the Pleistocene had disappeared from Missouri and others had withdrawn to other parts of the continent. Conspicuous among disappearances from the continent were tapirs, horses, camels, sloths, mammoths, and mastodons. Other groups like the peccaries, armadillos, alligators, and musk-oxen, still represented on the continent, had disappeared from the Missouri area. That the early Indians saw some of these creatures in Missouri is fairly certain, but which ones is less sure, as is indicated elsewhere.

There is a natural curiosity concerning the disappearance from Missouri of such a large number of kinds of mammals before the white man came. Two of the most popular explanations, "the great cold" and "the destructiveness of Man", are based on speculation rather than sound evidence. We have seen good reason to believe that during the major part of the Pleistocene our climate was not markedly different from that of today. It is even likely that the trend was a generally higher average temperature with less sharp differences between extremes during much of the time. The southern half of Missouri may well have been relatively mild even during the time of greatest ice advance.

So far as Man's influence on the extinctions is concerned, there is as yet no positive proof that some of the disappearances had not been accomplished before Man came. However, it is likely that Man and mastodon were contemporaneous for at least a short time, and it is possible that the earliest Indians of Missouri saw representatives of some or most of the other groups that were gone before the white man came. To blame the early Indians for the disappearance of the mammoths, the mastodons, the sloths, tapirs, horses, and others, is to attribute to these early people the wasteful tendency of the white man, but this is not in keeping with what we know of the Indians of all time.

The "American Buffalo" *(Bison)* was found in Missouri by the first white settlers, and they may have helped speed the departure. Even so, the disappearance of *Bison* from Missouri was probably more the result of interfering with the animals' freedom of range than their actual destruction by Man. The migration of the great herds to the western province had left behind only small scattered bands.

The disappearance of the musk-ox *(Symbos latifrons)* from Missouri coincided closely with the disappearance of the ice. Disease may have accounted for the peccaries' departure. There is little evidence that the Indians utilized them to any great extent for food. The extinct group seems better fitted for survival than the present day representatives of the southwest.

One of the surprises is that the elephants and mastodons, the sloths and the tapirs survived as long as they did. These are old fashioned mammals that really should have disappeared when the modern mammals took over, just as so many other old fashioned groups disappeared. The camels were all but gone from North America by the beginning of the Pleistocene.

One of the most intriguing problems, as many see it, is the disappearance of the horses. The answer to this question must apply equally well to all parts of North America and to all of South America, for the white men did not find them on these continents. It is more likely that the disappearance was coincidental with the late Pleistocene rather than the result of some conditions peculiar to this epoch. So far, no satisfactory explanation has been offered although it is generally recognized that the horse is old, as the age of races is stated (not in years, but condition). The horses' nearest living relatives, the tapir and the rhinoceros, are all but gone from the earth.

THE MAMMAL SKELETON

The outside of an animal tells where it has been;
the inside (skeleton) tells what it is.

Fig. 31. Comparison of human skeleton with that of horse, *Equus caballus*. From mount in the American Museum of Natural History.

This axiom quoted most often by students of vertebrate paleontology, is a succinct way of explaining that the fundamentals of the skeleton are less influenced by the environment than are such things as the body covering or the size and shape of the animal. The classic illustration is the comparison of the small rabbit-like "cony" *(Hyrax)* of Biblical history with the clumsy looking "sea cow" (Manatee), which are really "brothers under the skin". The elephant is sometimes called a "kissing cousin" of both of these and not too distantly related to the mice! If there was no basis for the axiom, the student of Pleistocene and earlier verebrates would be hard put for materials. Frozen mammoths and mummified carcasses are hard to come by, and the collector is happy to find a good collection of bones or teeth.

In this place, a lexicon of terms used to describe vertebate hard anatomy must be limited Only the features of limbs and teeth that may be useful to the beginner will be described, and these only in general terms. It will be evident early in the work of the tyro that there are many exceptions to most of these generalizations, and it is hoped that he will be as tolerant and understanding as is expected of the specialist who is accustomed to minutiae.

ENDOSKELETON VS. EXOSKELETON

The entire compliment of bones in the skeleton of most mammals belongs to the *endoskeleton* (internal) as opposed to the *exoskeleton* (external) which includes such things as hoofs, claws, and the dermal scutes of armadillos. Strangely enough the teeth too belong to the exoskeleton although they function as an integral part of the jaws. So commonly are the teeth thought of as part of the endoskeleton that they will be listed here under this heading although they originate in an entirely different manner.

Bones of the endoskeleton are commonly grouped under the categories *axial* and *appendicular* skeleton. The former includes the skull and jaws, the vertebral column, and the ribs. The appendicular skeleton includes the limbs and the bony girdles to which they are attached.

AXIAL SKELETON

In identifying fragmentary remains of Pleistocene vertebrates, the skull and jaws are most important to the beginner and these primarily because of their intimate association with the teeth. This is not to say that a skull with missing teeth is not of value, but few generalizations concerning mammalian skulls would be helpful. Tooth structure will be considered in a later paragraph.

The vertebrae of the spinal column are distributed in regional groups known as cervicals (neck), dorsal and sacral (back), and caudal (tail). The number of cervicals in mammals is seven with very few exceptions. Even the long neck of the giraffe and the short neck of the whale are not exceptions. There are no "free" ribs in the cervical region, but each vertebra bears a short lateral process or vestigial rib that is thoroughly fused to the vertebra by two surfaces separated by an opening. The first vertebra of this group, the atlas, is deeply cupped at the anterior end to receive the two knobs (occipital condyles) at the base of the skull. The second unit, the axis, has a projection (odontoid process) on the anterior face, either peg- or spout-like, about which the atlas rotates. The dorsal series is divided into the rib-bearing thoracic vertebrae (from 12 to 14) and the ribless lumbars (5 to 7). The sacrum consists of from two to five fused vertebrae to which the pelvic (hip) girdle is fused. In Man the sacrum is the lower end of the spine (except-

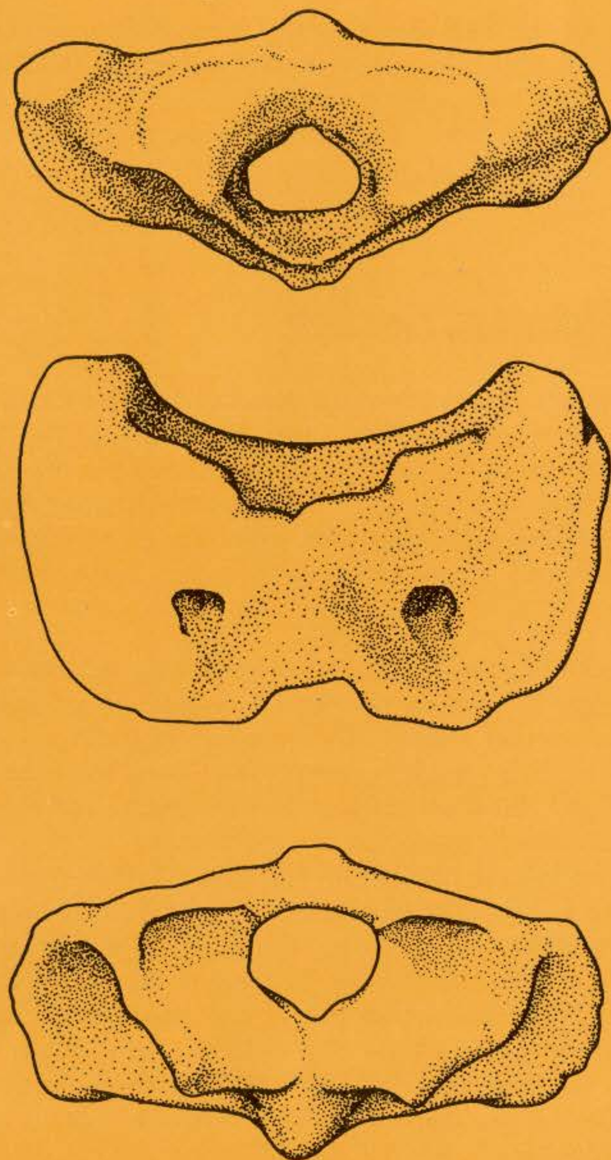


Fig. 32. Atlas of musk-ox, anterior, superior, and posterior views; x ½.

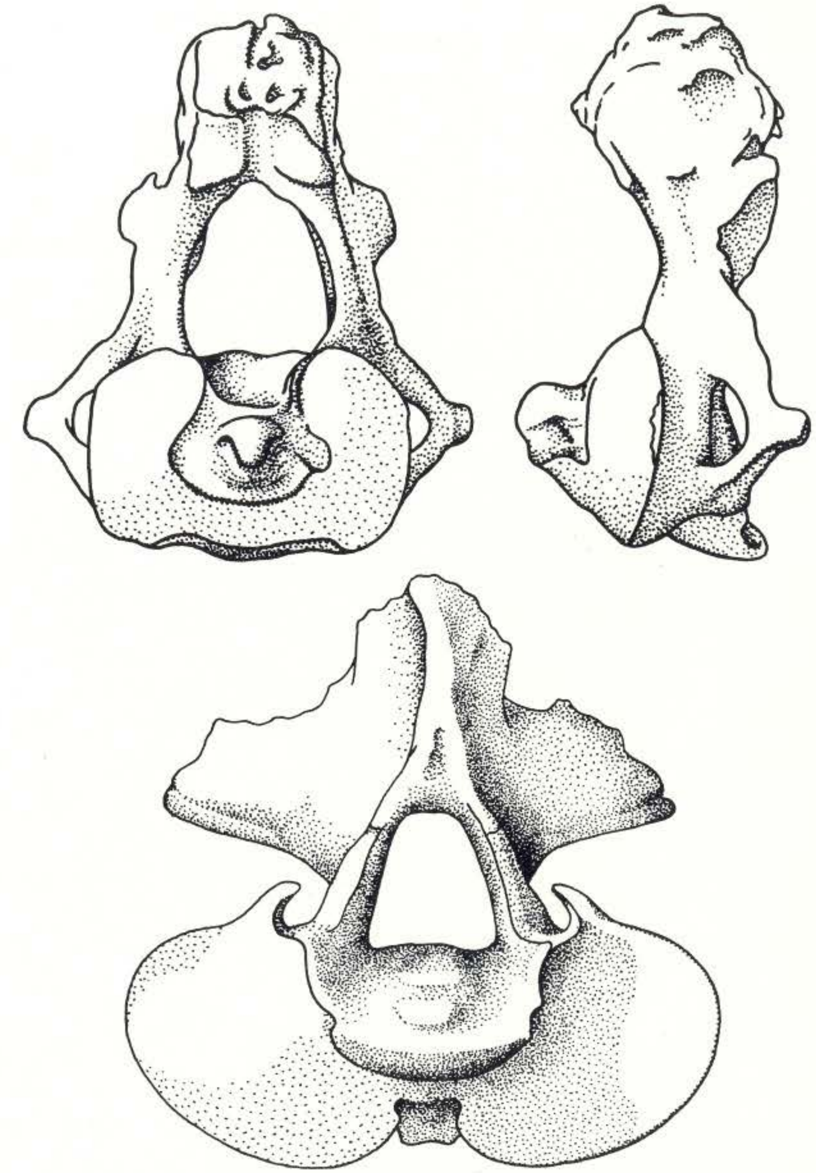
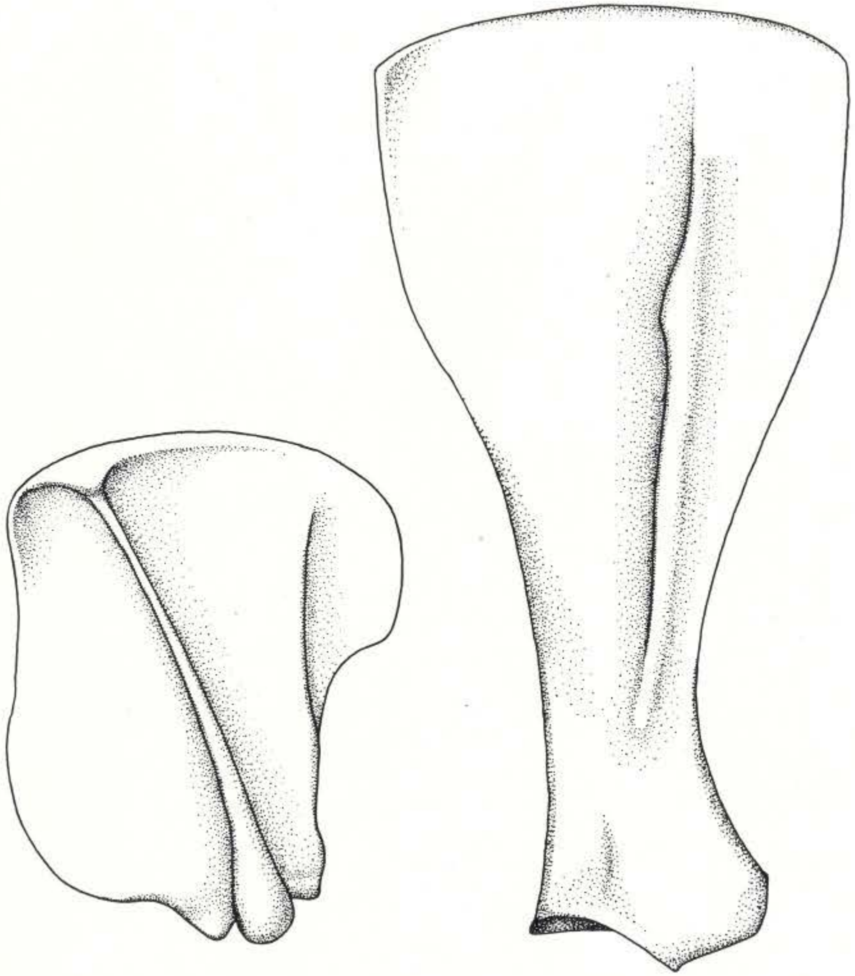


Fig. 33. Odontoid process of axis. Spoutlike in Pleistocene horse (anterior view), x 1; and peg-shape in Pleistocene ground sloth (anterior and left-lateral views), x ¼.



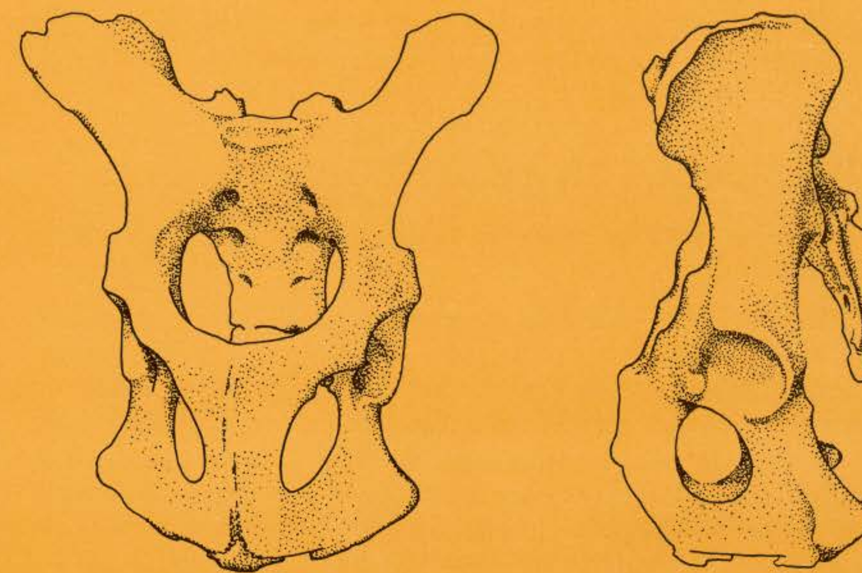


Fig. 34. (Left) Right scapula of Black Bear and a Pleistocene horse. Outer lateral views.
(Above). Pelvis of Black Bear, anterior and left lateral views.

ing the coccyx) and forms the back of the pelvic basin. The caudal series is markedly variable in number from group to group. All are ribless.

APPENDICULAR SKELETON

This category includes the limbs and the girdles to which they attach.

Girdles.—The shoulder or *pectoral* girdle in all mammals lack rigid attachment to the axial skeleton, and in none does it depart greatly from that in Man. The shoulder blade or *scapula* is a comparatively thin, platelike bone, fan-shaped with a thin ridge or buttress on its outer surface. The narrow (lower) end is thickened and excavated, shallowly cuplike, to articulate with the rounded upper (proximal) end of the upper arm bone (humerus). In many forms a rodlike bone, the collar bone or *clavicle* connects the lower end of the scapula loosely with the breast bone or *sternum* as in Man. In animals like the horse that do not rotate the front limb freely, the clavicle is missing.

The hip or *pelvic* girdle consists fundamentally of two pairs (rights and lefts) of three bones, two of which, the *pubis* and *ischium*, form a sort of basket that is suspended from the *sacrum* by the third, the *ilium* (hence the sacroiliac union or joint that some times causes trouble for humans). The three of each side meet in a deep, cuplike concavity, the *acetabulum*, into which fits the ball-like process at the head of the upper leg bone or *femur*. With the fundamental structure in mind as is illustrated in the accompanying figure (Fig. 34), it is not difficult to identify the corresponding units in the pelvis of any mammal, regardless of its degree of modification.

Limbs.—In the accompanying chart (Fig. 35), is diagrammed the fundamental arrangement of building blocks that form the limbs of the vertebrates. This departs little from the arrangement in the most ancient forms and is typical of many

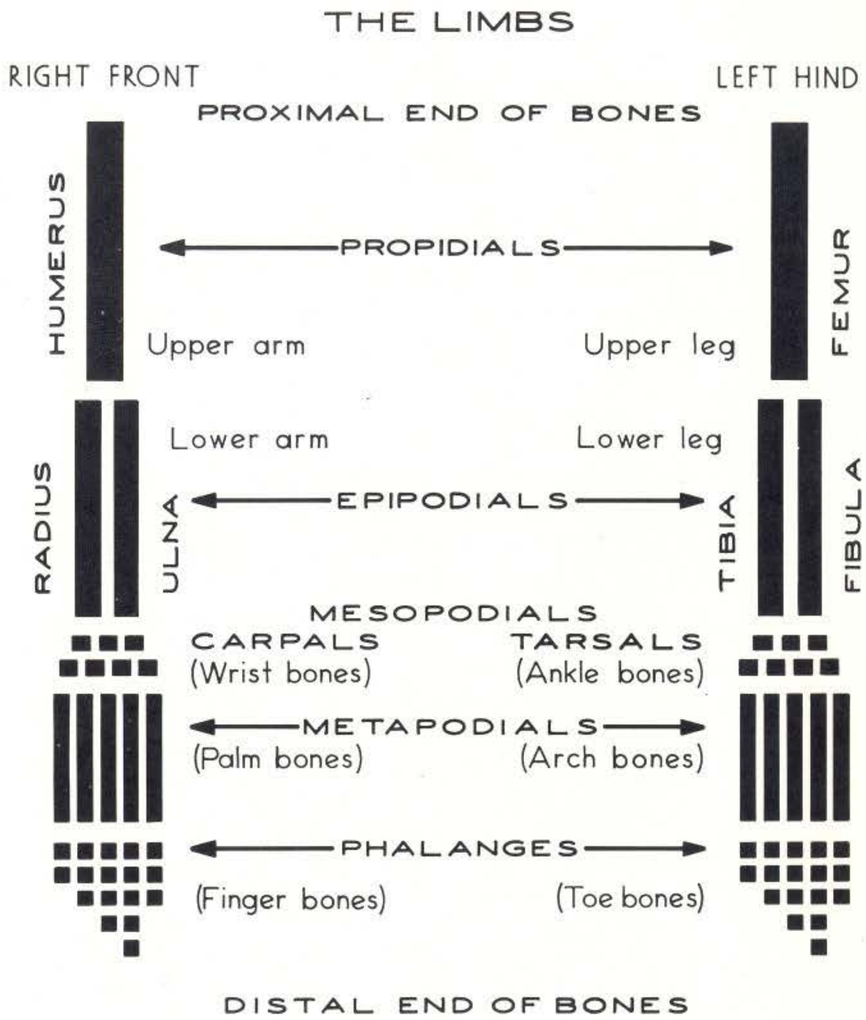


Fig. 35. Fundamental structural units of the limbs of vertebrate animals.

of the higher vertebrates of today. A study of the chart and comparison of its parts with the units in the human limbs will give meaning to descriptions of Pleistocene mammals. With the top of the diagram toward the observer and the right hand (palm up) to the right of the diagram, the bones of the arm and the units of the diagram are in analogous position. Fingers (and toes) are numbered from I to V, starting with the thumb (or great toe).

Evolution of limbs.—The geologic history of most vertebrate groups seems to justify another axiom:

Nothing new is added—change consists of loss, combination of units, and new use for old parts.

The history of the horse, as briefed in the accompanying illustration (Fig. 36) which shows changes in the hand and foot from the first recognizable horse to the horse of today, illustrates this well.

The reduction in number of toes in all the mammals has followed a definite pattern, the loss starting with I, then V, II, and IV, in that order. An animal with four toes has retained II, III, IV, and V; one with three toes has II, III, and IV; one with two toes has retained III and IV. In all single toed forms, the unit retained is number III.

The division of the ungulates (hoofed animals) into Perissodactyls (Greek: *perissos* odd + *daktylos* finger, toe) and Artiodactyls (Greek: *artios* even + *daktylos* finger, toe) is based on the manner in which the weight of the animal is distributed rather than the number of toes. In the first group, the weight is on the middle toe (III as in the horse). In the second group, it comes between III and IV. The tapir is a perissodactyl but has four toes on the front foot.

Fusion of parts.—Another biological axiom states that: *An organ not used tends to atrophy (Greek:* a *not +* trephein *to nourish) and disappear.*

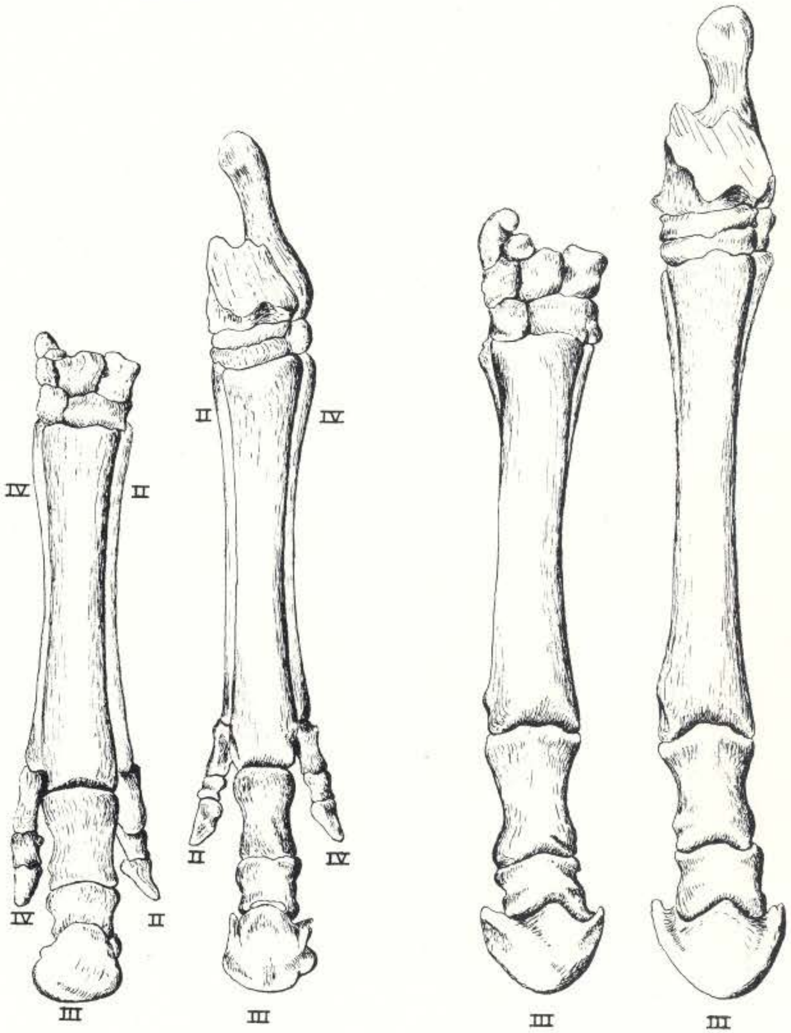


Fig. 36. Evolution of the foot of the horse. Front and hind foot of *Protohippus* and *Equus*, from left to right. From W. B. Scott. See also ancestral mammal foot in Figure 37.

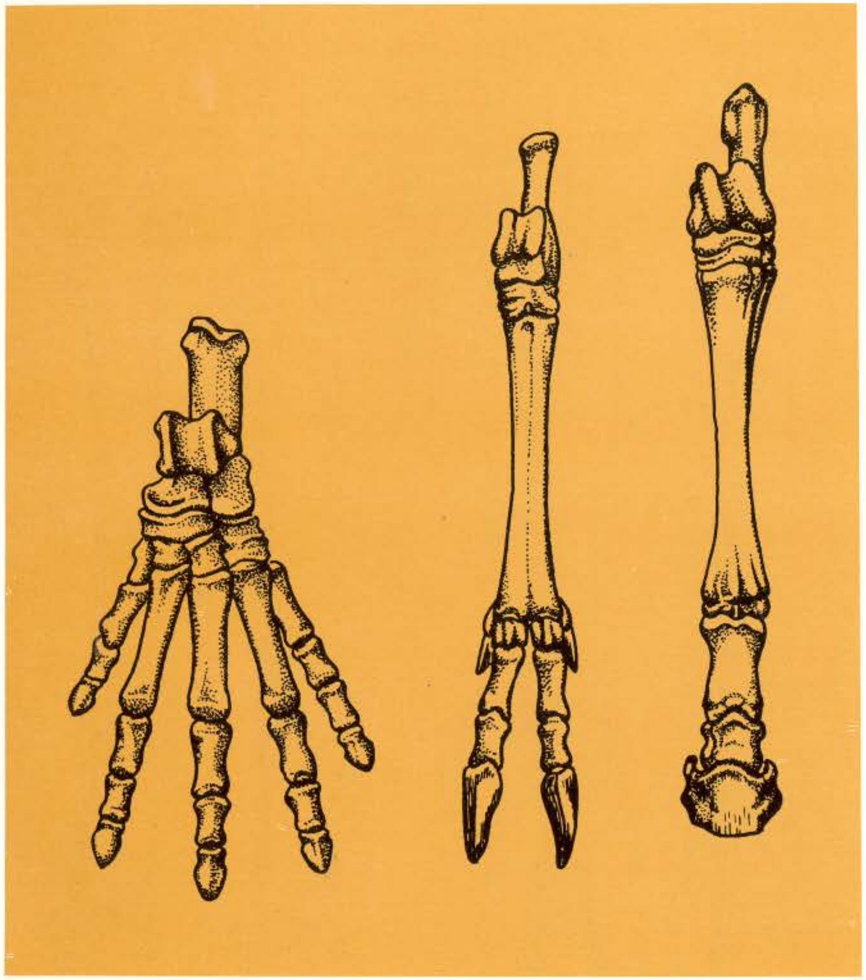


Fig. 37. Comparison of ancestral (generalized) hind foot with specialized foot of an artiodactyl (the "Pudu deer") and a typical perissodactyl, the modern horse. Note in the Pudu the fusion of metatarsals III and IV and the retention of the distal ends of II and V. In the horse the "cannon bone" (metatarsal) is number III and the "splints" are the proximal ends of II and IV.

Perhaps the best illustration is the tendency for the epipodialia of some mammals to disappear or fuse together. The hand (yours), lying on the table palm up, feels awkward, and without thinking it is turned palm down. It is evident that in making the change the radius crosses the ulna. This ability (propation and supination), exceptionally developed in Man, added to the great freedom of movement of the hand in all directions from the wrist is one of the structural features that sets Man apart from all other animals. In this remarkable hand, Man has a tool which is capable of implementing the creations of his extraordinary brain. In animals that retain some degree of this fore-arm-twisting ability, as in the raccoon, the bear, and the dog, the radius and ulna remain separate units. In animals like the horse (a typical perissodactyl), the midlength of the ulna shaft is lost, but the proximal end is fused to the radius to form a hook that hangs the lower arm from a concavity in the distal end of the humerus. In the peccary (an artiodactyl); the ulna is fused along its entire length to the radius.

There is a tendency in most mammal groups for the *fibula* to be greatly reduced. This is to be expected, for twisting ability in the lower hind leg is rare. In some forms, only the distal end of the fibula remains and is fused to the *tibia*. There is a tendency for *metatarsals* III and IV to fuse together in the artiodactyls to form a "cannon bone" as shown in Figure 38 because these two toes function as one.

Specialization in limbs.—A conspicuous reduction in parts is so commonly associated with highly specialized limbs that the two factors are likely to be considered synonymous. Certainly, the very highly specialized legs of the horse are the result of loss and union of parts, but the legs are *specialized* because they perform a given function better than do the legs of another animal. In the case of the horse, it is the answer to Nature's attempt to provide the animal with great speed on hard land surfaces. However, there is no specialization in the limbs

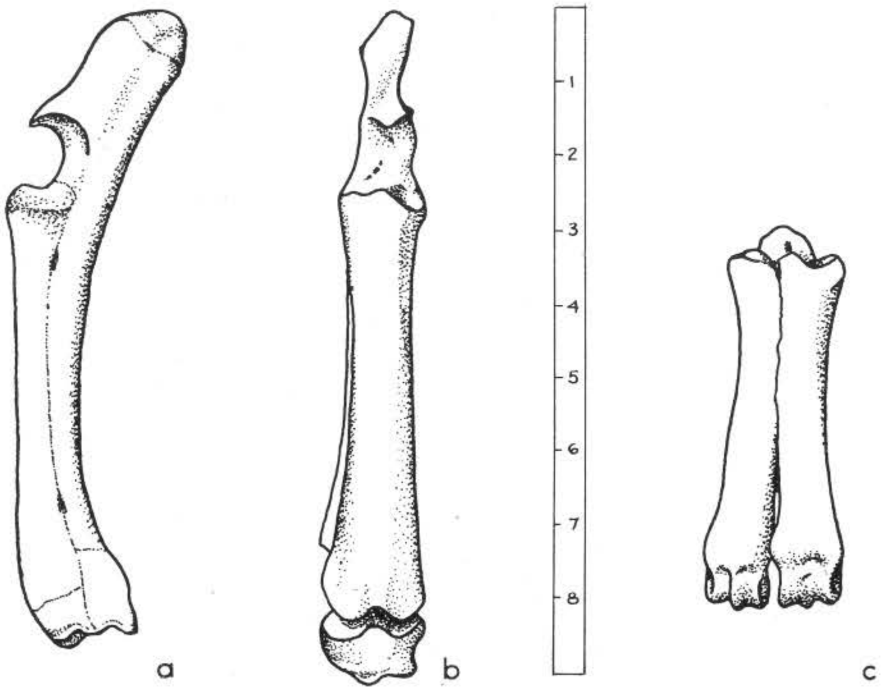


Fig. 38. Leg bones of a Pleistocene peccary showing fusion of bones and their epiphyses. (a) lateral view of fused radius and ulna with indications of distal epiphyses of radius and ulna and proximal epiphyses of ulna; (b) anterior view of fused radius and ulna with separate distal epiphyses of radius (the distal epiphyses of ulna is missing); (c) the partial fusion of metatarsals III and IV.

of mammals that equals that of the human hand. In this case, the number of units is only a little less than in the most primitive hand, but the flexibility has no equal. In the human foot too, the reduction of units is negligible, but the bones form the best platform by far for supporting the erect body. These features were Man's birthright when he first appeared on earth, and they argue strongly that he has always "stood on his own two feet"!

TEETH

It is fortunate that teeth are relatively resistant and are less likely to be destroyed than are bones. Teeth are generally the best means for identifying mammals, and in cases of accumulated vertebrate scraps, such as that at the Herculaneum crevice in Jefferson County (MGSQV-1102), they constitute almost the only means for satisfactory determination.

For the most part, the teeth of mammals, remarkably varied as they are, can be described in terms of departure in number, arrangement, and shape from a comparatively simple form, which is essentially the human tooth development.

Number of Teeth.—Among the mammals, the normal maximum number of permanent teeth is 44, as in the pigs. The number in Man is 32, a departure from the primitive by 12. The terms, *incisors, canines, premolars,* and *molars,* to designate "nipping teeth", "eye teeth", "bicuspids" (these are the cheek teeth that are preceded by "milk" or deciduous teeth), and the molars of man, apply to the dentition of all the mammals. Ordinarily, the tooth formula for mammals is written as follows: i.2/2, c.1/1, p.3/3, m.2/2 $\times$ 2 = 32. This is the formula for Man and means that on one side of the face there are two incisors above and below, one canine above and below, three premolars above and below, and two molars above and below. Doubling the number for one side gives the total. An individual tooth may be designated: i_2, p^1, m_2, etc., meaning lower incisor two, upper premolar one, and lower molar two.

Building Material of Teeth.—Chemically, tooth material is calcium phosphate, the same as the composition of bone. This is an important thing to remember because teeth and bones are not soluble in some acids and, therefore, can be cleaned easily from certain coatings or types of matrix. Calcareous cave deposits (drip stone) or the calcareous nodules in loess (loess kindchen) can be dissolved in a solution of about 10 percent glacial acetic acid, and the bones or teeth they may contain will not be affected.

The main body, the essential part of the tooth, is composed of bonelike substance called *dentine* or ivory. In the human tooth and in those of most other mammals, there is a relatively thin capping of *enamel* which is appreciably harder than the dentine. In many kinds of mammal teeth, there is a third kind of material called *cementum* that is somewhat less hard than the dentine and covers a small part or all of the other materials of the tooth. These three kinds of material, with their varied resistance to wear, are of prime importance to animals that must grind their food as do horses and cattle and to many others as is mentioned later.

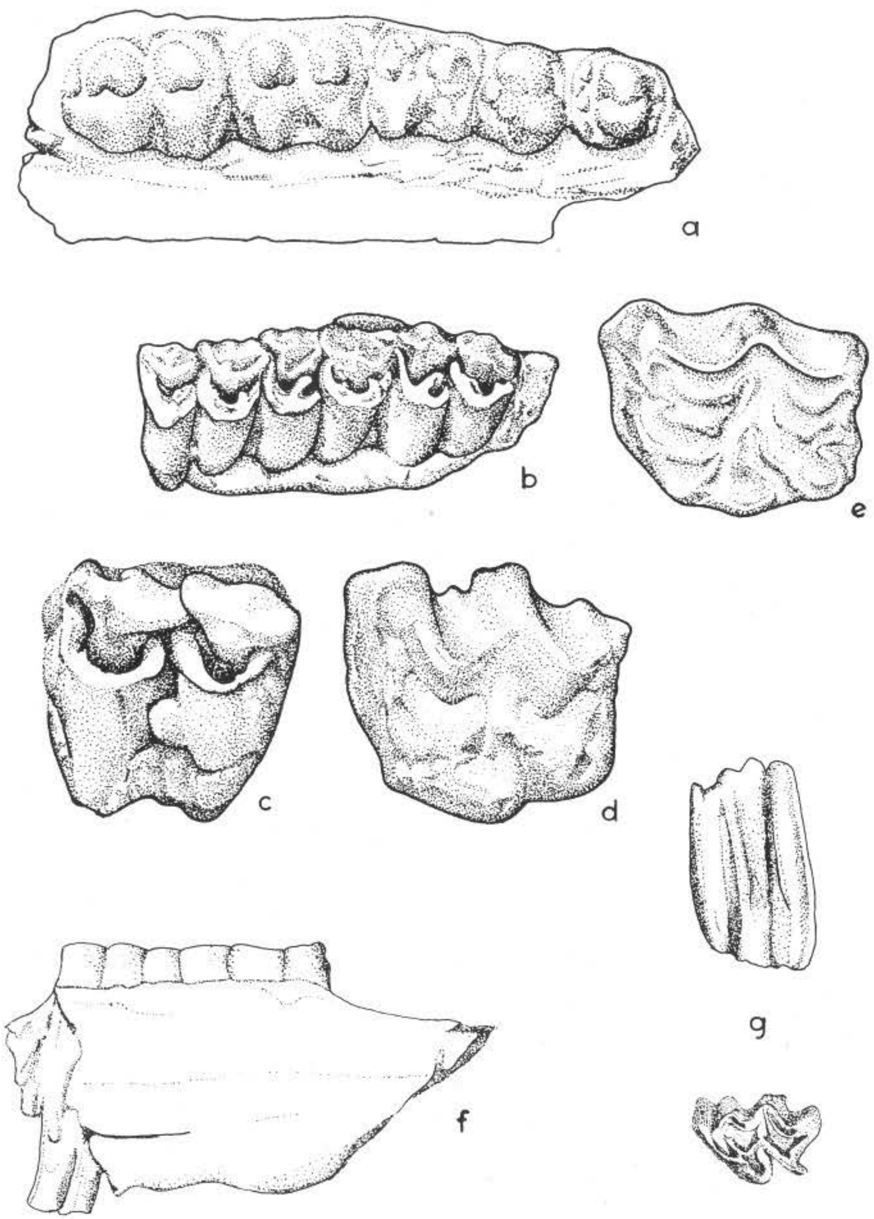
Shapes of Teeth.—The human tooth is described as *brachyodont-bunodont*, which is very different from the tooth of the deer that is described as *hypsodont-selenodont*. Brachyodont (Greek: *brachy* short + *odontos* tooth) refers to the height of the crown in relation to that of the root (Fig. 39-a). Hypsodont (Greek: *hypsos* height + *odontos* tooth) refers to an exceptionally high crown as in the horse. Terms such as *bunodont*, *selenodont*, and *lophodont* refer to the configuration of the *occlusal* (grinding or biting) surface of the crown. A *bunodont* tooth has only comparatively simple rounded bosses or *cusps*. *Lophodont* teeth have cross ridges and valleys on the crown, and *selenodont* teeth have parallel pairs of crescentic ridges the long axis of which parallel the cheek.

Special Tooth Forms.—Although most mammal teeth have roots which at some stage tend to close and inhibit further growth, some, like those of the armadillos and ground sloths have no real roots. In these, the teeth continue to grow and, thus, compensate for the wear of the occlusal surface occasioned by the animal's trituration of its vegetable food. Teeth of these edentates are peculiar also in that they have no enamel layer and no cement.

Another type of constant growing teeth is illustrated by the incisors of the gnawing animals like the squirrels or the beaver. The *scalproform* (chisel-like) teeth have enamel on the anterior (forward) side only. The opposed (upper against lower) teeth remain sharp edged through the very act of gnawing because the enamel is more resistant than the body of the tooth. Very often, one of these gnawing teeth is broken, and the opposed tooth with nothing to grind against continues to grow to the point of preventing the closure of the mouth, thus, resulting in the starvation of the animal.

As pointed out elsewhere, the tusks of the elephants are not canines, as are the tusks of the swine, but are really incisors that have "gone wrong". Except for a thin cap at the tip of the young tusk, these incisors are made exclusively of dentine (ivory).

In the carnivores, one tooth on each side (above and below) is highly specialized for slicing flesh and is called the *carnassial* tooth. In the wolf, the carnassial teeth are p^4 and m_1.



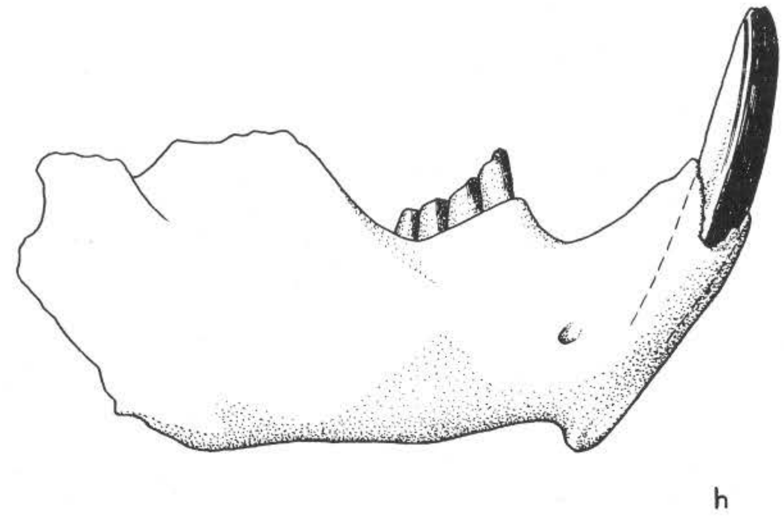


Fig. 39. Selection of Pleistocene mammalian teeth to illustrate types of crowns and roots. (a), buno-lophodont crown of a peccary; (b) and (c), worn and unworn selenodont crowns of two cervides; (d) and (e), unworn and worn crown (in plaster) of horse upper molar; (f) lateral view of three horse teeth in fragment of lower jaw; (g) oral and lateral views of high crown and root of horse, recorded in plaster; (h) lateral view of beaver jaw showing enamel confined anterior face of incisor. The teeth of horse, deer, and beaver are hypsodont ("constant growing"); the teeth of the peccary are brachiodont (short roots).

BONE GROWTH

In the origin of bones, there are two distinct groups: *membrane* and *cartilage* bones. In the first group, a membrane is gradually ossified from the center of the piece toward the margins. The development of the human cranium during the early stages of growth is typical of mammals and well known by all. It is obvious that a good fossil skull of a very young animal is not to be expected. The bones of the arms and legs illustrate the second group. In this group cartilage rods gradually ossify from a center at about the midlength of the member with complete ossification marking maturity.

Most land mammals begin to support the body weight on their legs at a very early age. A young antelope, almost within minutes after birth, can scamper off with surprising speed! Such use of the leg bones would be disasterous were the end articulations not perfect, and this presents the enigma of bones far short of full length, yet with perfect terminals at all stages. The obvious and only explanation is that the increment is not at the terminals but between the shaft-proper and the actual ends, the *epiphyses*. Actually, in these bones, there are three centers of ossification—one at midlength of the shaft and one in each epiphyses—and the three parts become thoroughly fused together only at maturity. In the skeleton of a young animal, the three parts of a bone are commonly found as separate units and as such are likely to puzzle the beginning bone collector. He is accustomed to identifying a leg bone as a unit, but he must also learn to identify its component parts as shown in Figure 38.

Another feature in the growth of a bone is the remarkable ability of the bone to repair itself when broken during the life of the animal. A natural splint, a spongy mass of bone, forms about the fracture fairly rapidly and persists till the parts are thoroughly knit together. It is seldom that the splint is completely reabsorbed, thereby, leaving a record of the fracture, even in the fossil skeleton of a very ancient animal. The skeleton of a mastodon at the University of Wisconsin records an accident that is interpreted as the fracture of several ribs on one side of the animal that was received during a butting contest with some adversary.

SUGGESTIONS TO COLLECTORS

For the most part, suggestions to collectors of Pleistocene bones apply equally well to collectors of other things, such as rocks, minerals, Indian relics, and plants. Above all, the cardinal principle in collecting is the recognition of the fact that almost any exploration involves private property. Most students of nature not only ask for permission to explore, but also recognize that such permission carries with it certain responsibilities. Gates are left open or closed as they are found. Care is taken not to break fences, and growing crops are never trampled. Stampeding livestock is the mark of the unthinking amateur.

Of an entirely different nature, but most certainly of great importance, is the general principle that private collections should be subordinated to the best interests of science and the public in general. Any person who has spent some time in the effort to decipher some phase of our immediate or remote past has experienced frustration because this principle has been ignored by some collector. There is no question but that the finder becomes the rightful owner if his collecting has the sanction of the property owner, but a private collection may become a hiding place for an important piece of scientific information. The owner of a private collection should make his findings known and have them checked by the specialist to see if among the finds there are key pieces that should be housed in some responsible museum where it will be properly recorded and may be studied now and in the years to come. It is suggested here that owners of private collections of a geological or paleontological nature seek the advice of some institution, such as the Missouri State Geological Survey at Rolla or the Department of Geology at one of the Universities in the state. In no case will a specimen be kept by an institution without permission, and in some cases it will be suggested that the collector retain his find. A list of some of the many institutions where trained professional help can be obtained by collectors free for the asking is appended in the section on "Help is available in identifying your fossils".

There are many ways in which the collector may eat his cake and have it too. Teeth, for instance, ordinarily are sufficient to identify the animal. Figure 39-a records in moulder's plaster the tooth of an Ice Age horse. The crown was pressed into modeling clay as was one side of the tooth. Into the depressions was poured the plaster having a consistency of thick cream. Actually, this forms a record that is as valuable as the original. And speaking of the value of fossils, in general, there is no monetary value attached to them. Their true value is only scientific. Museums seldom buy fossils.

It is important that the collector knows the location of his finds as accurately as possible and will keep a record of this information with his finds. Usually and preferably, this record includes the section number and the particular part of the land section, as well as the township and range, in which the find was discovered. All this information may be found on the owner's tax receipt of the property at the discovery site.

Another essential is to give a complete return address with all correspondence. I often wonder what some inquirer thinks when I have my reply returned because of an inadequate address!

CAVE EXPLORATION

So many remarkable records of Pleistocene vertebrates have come from Missouri caves that we may confidently expect a greatly embellished picture of Pleistocene life through the continued work of speleologists. However, this work requires special skills for the dangers of cave exploration are as numerous as the thrills. I have asked Dr. Oscar Hawksley of Central Missouri State College, who is one of our most experienced cave scientists, to make some suggestions in this area, and he has complied as follows:

The number of cave explorers has increased sharply in recent years and with this increase has come a mounting tide of accidents and even fatalities. Most accidents have been caused by ignorance of basic safety rules and by the inexperience of the spelunkers. Some of the most important safety precautions are briefly noted below.

Don't go alone.—One or more companions, properly equipped is a necessity.

Have three sources of light.—There is less chance of actually getting lost in a cave than there is of running out of light. Three suggested sources of light are: 1) carbide lamp with a good supply of carbide, water, and spare parts; 2) flashlight with spare batteries and bulb; and 3) candles.

The carbide lamp is the most widely used source of light. It is economical, dependable, and easily repaired. Flashlights often malfunction in caves.

A hard hat.—This is standard equipment for most cavers. It not only provides a handy place to attach the carbide light and leaves the hands free, but frequently it saves a life or prevents injury when a blow on the head is received from falling rock or a low ceiling projection.

Flooding.—There is frequent danger of flooding in some Missouri caves. Caution should be used in caves which have, or show signs of having, large streams.

Climbing in caves is dangerous.—Pit or sinkhole type caves are among the types most likely to have fossil deposits, but most of the fatal accidents take place in this type of cave. Inexperienced and overconfident persons are the ones usually involved. One should never attempt to enter such a cave without a thorough knowledge of rock climbing techniques, such as rappelling, proper belaying, prussik climbing, or cable ladder climbing. Safety lines, in the hands of an experienced belayer, should be used at all times. If you don't know these techniques, don't try to climb. There is danger even with proper equipment and experience. The closest chapter of the National Speleological Society to your area of interest may be contacted through the Missouri Speleological Survey, in care of the Director of the Missouri Geological Survey at Rolla, Missouri. These local organizations have the proper equipment for such work, and they not only instruct their own members in the proper techniques of cave exploration, but they are also more than willing to help other interested people.

HOW A CAVE EXPLORER MAY ASSIST THE PALEONTOLOGIST

The spelunker (cave hobbyist) or the speleologist (cave scientist) may expect to locate bone deposits in caves and should know what to do about such finds. Some of the things which he may do in reference to fossils are listed below:

Observation.—Carefully note and record the position of new locations for later collection by trained personnel. This may result in the extension of the range of known species or the discovery of new species.

Reporting.—To be of any scientific value, observations must be properly reported. In Missouri, reports of bone finds in caves may be sent to the office of the State Geologist at Rolla, Missouri, where they will then be referred to the Missouri Speleogical Survey which will send an experienced team to investigate. Consult the appended list of cooperating schools.

Recovery.—The average caver should not attempt to recover fossils, other than isolated or scattered bones, without supervision by trained personnel. Disturbance of the site or improper handling of the material may reduce or destroy the value of the deposit.

What to collect.—A trained and skilled Pleistocene bone collector will collect everything. For all vertebrates except such things as the turtle, the most important items for quick identification are the teeth. However, in many of the mammal groups, there are distinctive features in certain parts of the skeleton, such as the conspicuous process on the outer side of the proximal (upper) end of the horse femur (thigh bone). Even vertebrae are very highly distinctive in some groups, like the snakes, for instance. So again, he must collect everything.

How to collect.—The great majority of Missouri Pleistocene vertebrate remains are not conspicuously mineralized, and most of them start to split and disintegrate when exposed to the air. Perhaps the safest rule is to clean the bones as well as possible as soon as they are excavated and impregnate them with some hardening material at once. Very thin shellac is often used, and sometimes glue water serves well. The most common practice is to allow the bone to stand for a few hours in a very thin (thinner than cream) solution formed by dissolving commercial gum arabic in water. Tusks of elephants and mastodons when removed from the moist earth often disintegrate quickly. A safe way is to keep such specimens in water until a plan of preservation is evolved. Perhaps the best advice is to ask for assistance when complications arise.

Are the bones Pleistocene?—Even the most experienced professional observer may find himself at a loss in fixing the age of a bone. Some very old bones are as well preserved as the very recent, but some recent bones are found to be very poorly preserved. It is to be hoped that the beginner does not fall into the trap said to have caught an "expert". A horse skeleton was pronounced to be of early Pleistocene age, so the story goes, only to present a fine set of iron shoes on the hoofs when the entire skeleton was uncovered!

Some workers resort to burning a bone or the root of a tooth suspected of being old. For this purpose a propane blow torch is useful. If the object is charred and gives off the odor of burning hair, one may be sure that it is not really very old. On the other hand, if the bone is reduced to white ash without odor, the chances are good that it is hundreds or even a few thousand years old. The behavior depends on the preservation and, as has been pointed out, this is remarkably variable. Many of the bones of mastodons dug up in Missouri react as would bones of modern animals!

HELP IS AVAILABLE IN IDENTIFYING YOUR FOSSILS

In most of the Missouri High Schools, one will find a teacher of science who can assist you in your identifications or will be able to direct you to some specialist in your particular field of interest. At any of the many colleges scattered over the state, there can be found one or more teachers who can give good suggestions.

In addressing inquiries, the name of a particularly qualified teacher may well be used if the name is known. In general this is not the case, and a list of such names in this place would not long be helpful. The personnel of schools change, and it is much better to address a particular department rather than a person. One may expect to get results by addressing the department of science, or biology, zoology, or geology at a particular school. Several of the schools, like the University of Kansas City and St. Louis and Washington Universities in St. Louis, have exceptional facilities. Letters addressed to the director of the St. Joseph Museum or to the Museum of Science and Natural History of the St. Louis Academy of Science at Oak Knoll Park in St. Louis, will receive prompt attention. The following list includes State institutions whose duty and pleasure it is to serve the public in every way possible:

The Director, Missouri State Geological Survey and Water Resources, Rolla, Missouri.

The Director, Missouri Resources Museum, Jefferson City, Missouri.

The Chairman, Department of Geology, Zoology, or Anthropology, University of Missouri, Columbia, Missouri.

The Chairman, Department of Geology, Missouri School of Mines and Metallurgy, Rolla, Missouri.

The Chairman, Department of Biology, Lincoln University, Jefferson City, Missouri.

The Professor of Geology, Southeast Missouri State College, Cape Girardeau, Missouri.

The Professor of Geology, Northwest Missouri State College, Maryville, Missouri.

The Head, Division of Science and Mathematics, Northeast Missouri State Teachers College, Kirksville, Missouri.

The Professor of Geography and Geology, Southwest Missouri State College, Springfield, Missouri.

The Professor of Biology, Central Missouri State College, Warrensburg, Missouri.

PLEISTOCENE BONE DISPLAYS IN MISSOURI

It is unfortunately true that most of the many bones of Ice Age animals that have been excavated in Missouri during past decades have gone either to museums in other states or to other countries. A goodly number have become part of private collections, most of which have soon after been dissipated. Of the bones that remain in public institutions, little provision has been made for their display. One outstanding exception is the State Museum of Natural Resources in the Capitol Building at Jefferson City, where an abundance of mastodon and mammoth bones and teeth, along with lesser representation of other typical Pleistocene animals are on display. A small collection of mammoth, mastodon, peccary, sloth, and tapir remains may be seen at the new headquarters building of the Missouri State Geological Survey and Water Resources at Rolla.

Spreading knowledge through suitable displays is one function of all educational institutions, but it is seldom that sufficient funds are available to function properly in this area. At the University of Missouri in Columbia, there is displayed occasionally a small collection of Pleistocene remains, but most of the material has to be stored and used for research purposes. There is a considerable collection of Pleistocene bones and teeth at Washington University in St. Louis, but here too, most of the material must be stored. Pleistocene vertebrate remains are being accumulated at Central Missouri State College, but as yet there is no provision for display. Bones at the High School at Eldon are not regularly displayed.

An exceptionally large upper arm bone (humerus) of a mastodon from Boone County, MGSQV-1070. "Little-dog" and "Schnoops" can't believe it.

APPENDIX

One who makes use of the following lists should be aware of the fact that the bounds of accuracy are of necessity somewhat elastic. It seems impossible to record a series of events that have taken place over an interval starting more than a century ago and ending today without some error, for the compiler is forced, in some cases, to arbitrary decisions. For instance, "The Sedalia Mastodon Swamp" (MGSQV-1024) was recorded by Oliver P. Hay in 1924 (p. 29) as "about 4 miles southeast of Sedalia" whereas Branson recorded it in 1944 (p. 348) as "seven miles south of Sedalia". Hay's location is here accepted because the ownership of the land at the time was verified by him at the office of the recorder. Or again, the location "four miles south of Fenton on Romain Creek in St. Louis County" (MGSQV-1054) is herein recorded as a locality in Jefferson County in the belief that the reporter would be less likely to mistake a distance and a well known stream than fail to recognize that he had crossed a county line. It is felt that although exact dates, precise locations, and accurate identifications are highly desirable, the failure in some of these details does not warp materially the over-all picture of kinds, abundance, and general distribution of our Pleistocene animals—in which the general public seems most interested.

Of course the scientist will wish to sift through conflicting statements and make his own decisions concerning localities and identifications.

It will be found that in places more than one locality number has been assigned to what seems to be a single or several closely adjacent points. In such cases several finds each separated from the other by an appreciable interval of time and each by a different collector is emphasized.

MISSOURI PLEISTOCENE VERTEBRATE LOCALITIES

MGSQV 1001*. **Hickory County** (NW¼ sec. 9, T. 38 N., R. 22 W.). This locality description does not correspond with reports that the find was made in Benton County. The remains, consisting of elephant, mastodon, bison, sloth, horse, deer, and elk, were reported to Cuvier in 1806 by B. S. Barton. Albrecht K. Koch excavated a mastodon skeleton here in 1840. The bones went to the British Museum and elsewhere.

MGSQV 1002. **New Madrid County.**

A musk-ox skull found near New Madrid, probably about 1812. Presumably lost in a fire at the American Museum of Natural History.

MGSQV 1003*. **New Madrid County.**

About 3 miles downstream from New Madrid, an elephant tooth is reported to have been found in 1820.

MGSQV 1004*. **Gasconade County.**

The locality is a spring near Bourbeuse Creek. The original locality designation, Latitude 30° 20′ N., Longitude 92° W., is clearly incorrect. A mastodon skeleton was excavated here and reported by Albrecht K. Koch in 1839. He cited evidence of the destruction of the animal by Man.

MGSQV 1005*. **Jefferson County.**

The locality is about 1¼ miles northwest of Kimmswick near Rock Creek. It was first reported by Albrecht K. Koch in 1840 and has yielded remains of mastodon, elephant, horse, sloth, bison, musk-ox, moose, and deer. Some remains are to be found in the United States National Museum, Washington, D. C., the Carnegie Institution in Pittsburgh, Pennsylvania, Washington University, St. Louis, Missouri, and elsewhere.

MGSQV 1006*. **Benton County** (SE¼ sec. 24, T. 40 N., R. 23 W.).

There is some discrepancy in the various reports on this location. It was reported by S. H. Whipple in 1843. Elephant, mastodon, musk-ox, peccary, and deer have been reported, and the remains are to be found in the Museum at Cincinnati, Ohio.

MGSQV 1007. **Scotland County?**

A mastodon tooth is reported to have been found by a Mr. Slocum in 1955 about "3 miles south of the Iowa-Missouri line, close to a line between Granger, Missouri, and Mt. Sterling, Iowa."

MGSQV 1008*. **Iron County.**

At Viburnum, Missouri, in a clay bank at a depth of 40 feet, Bob Ketcherside, December 2, 1960, found the left front "cannon bone" (fused palm bones) presumably of a musk-ox; but this could be an exceptionally short bone from a bison.

MGSQV 1009*. **Jasper County.**

Nine miles southwest of Carthage, mastodon, elephant, bison, and testudo (turtle) were reported by Byron Ash in 1849.

MGSQV 1010.* **Stone County** (Sec. 6, T. 24 N., R. 23 W.).

At Galena, Missouri, Mr. Desor reported a mastodon find (skeleton, tusks, and teeth) at a depth of 70 feet in 1849.

MGSQV 1011. **Greene County** (NE¼ sec. 35, T. 30 N., R. 22 W.).

E. M. Shepard in 1898 reported the find of a large number of bones of Pleistocene age from a cave "on the Owen farm."

MGSQV 1012. **Greene County.**

"Elephant tusks" were reported by A. M. Stalnaker (in 1884) from a mud-filled cavern encountered while digging a well. These may have been mastodon remains.

MGSQV 1013. **Benton County.**

Dr. R. W. Gibbs reported finding peccary and mastodon remains in Benton County in 1852. There is some doubt concerning the location. It may have been the same site as is described under MGSQV-1006.

MGSQV 1014. **St. Louis County.**

At Geyer Avenue and 8th Street, St. Louis, Missouri, the find of a mastodon tooth was reported by G. C. Swallow in 1855.

MGSQV 1015.* **Boone County.**

On Bonne Femme Creek, the find of two elephant teeth was reported by G. C. Swallow in 1853 and again in 1858. One of these teeth is very likely the tooth that is in the collections at the University of Missouri, Columbia, Missouri, and labeled as V. P. 678.

MGSQV 1016. **St. Louis County?**

This locality is listed by Hay (1924, p. 139) as "*On Bluffs near St. Louis*". He reports that the find of a horse tooth *Equus complicatus*, was made by B. F. Shumard on the "Illinois Bluffs, stated to be 6 miles west of St. Louis". Because there are no bluffs of this name known to be west of St. Louis, Hay surmizes that Shumard intended to say "that the tooth had been found in the bluffs on the Illinois side of the Mississippi, 6 miles east of St. Louis".

MGSQV 1017. **St. Louis County.**

At 12th Street and Chouteau Avenue in St. Louis, Missouri, a musk-ox find was reported by Dr. Englemann in 1869. This location is very close to the remarkable Cherokee Caverns, recorded herein as MGSQV-1071.

MGSQV 1018. **Bates County** (Sec. 16, T. 38 N., R. 30 W.).

At Papinsville, the discovery of a horse tooth was reported by G. C. Broadhead in 1869 at a depth of 31 feet. The tooth is in the collections at the University of Missouri, Columbia, Missouri (V. P. 694).

MGSQV 1019. **Cass County** (Sec. 2, T. 46 N., R. 31 W.).

From the foundation of a bridge abutment on the Pacific Railroad about 4 miles northwest of Pleasant Hill, the find of a bison tooth was reported by G. C. Broadhead in 1870.

MGSQV 1020. **Ste. Genevieve County** (SW¼ sec. 1, T. 36 N., R. 9 E.).

Near St. Marys, a mastodon molar had been obtained from a well 18 feet deep by Mr. B. Pratt. The find was reported by Shumard in 1873. It is said that the tooth had been sent to the St. Louis Academy of Science.

MGSQV 1021. **Saline County** (Northwest part of T. 48 N., R. 21 W.).

Mastodon remains were reported as being present at this locality by F. B. Meek in 1873.

MGSQV 1022. **Bates County.**

At Papinsville, the find of the tusk of either a mastodon or elephant was reported by G. C. Broadhead in 1881. There is some question about the identification.

MGSQV 1023. **Pike County.**

From Calumet Creek which empties into the Mississippi River at the north end of Clarksville, a find of two mastodon teeth was reported by Mr. Jameson in 1875.

MGSQV 1024*. **Pettis County** (Sec. 25, T. 45 N., R. 21 W.).

About 4½ miles southeast of Sedalia a mastodon find was reported by R. A. Blair in 1879. Bones of eight individuals or more were found at a spring about 400 feet from the creek at a depth of 8 feet. Most of this material came to the University of Missouri, (V.P.665). The majority of the bones crumbled to fragments, and only few complete bones, jaws, parts of skulls, and many teeth remain. Flint implements were reported as associated, but there is doubt as to the nature of the association.

MGSQV 1025. **Cape Girardeau County.**

The exact locality of this find is not known. A musk-ox skull was reportedly found by President S. S. Laws and Professor J. W. Spencer of the University of Missouri, about 1880. The specimen is in University of Missouri collections (V. P. 680).

MGSQV 1026. **Caldwell County.**

The exact locality is not known of the mastodon tooth reported by G. C. Broadhead in 1881 as being found in this county.

MGSQV 1027. **Washington County.**

Near Big River, a mastodon tooth was reported to have been found by Mrs. P. G. Higginbotham. The date of her find is unknown.

MGSQV 1028. **Jackson County.**

On Campbell Street about 150 feet north of Independence Avenue in Kansas City, the find of a mastodon tusk was reported in 1880 by Mr. H. H. West.

MGSQV 1029. **Jackson County.**

About 20 miles east of Kansas City, a find of a supposed mastodon tusk was reported by Dr. F. A. Ballard in 1880.

MGSQV 1030. **Platte County.**

On Line Creek, which is in the extreme southeastern corner of the county, G. C. Broadhead reported in 1881 that Mr. J. C. Evans found a large mastodon tooth.

MGSQV 1031. **Cass County** (Sec. 35, T. 44 N., R. 33 W.).

On the farm of Senator C. S. Nelson, there was reported the find of a large bone, presumably mastodon. The date of the find is unknown, but is thought to be about 1887. Other bones were found at the same farm in 1926 and were sent to the State Museum in Jefferson City.

MGSQV 1032. **Buchanan County.**

Near St. Joseph, a mastodon molar is reported to have been found and sent to the St. Louis Academy of Science. The date of discovery is not known but falls sometime before 1924 when Hay published an account of the find.

MGSQV 1033. **Greene County.**

In Springfield mastodon remains were reported by E. M. Shepard in 1898 to have been found in 1855 in an excavation just south of the Kansas City, Fort Scott and Memphis Railroad. It was a mastodon tusk 8 feet long which lay in a horizontal limestone crevice.

MGSQV 1034. **Jackson County** (NW¼ sec. 33, T. 50 N., R. 33 W.).

Near the foot of Lydia Avenue in Kansas City, the find of a bison tooth was reported by Mr. J. E. Todd in 1896.

MGSQV 1035. **Jackson County.**

About 30 miles southeast of Kansas City, the find of an elephant tooth was reported by Dr. T. R. Thornton about 1889.

MGSQV 1036*. **Atchison County** (Sec. 22, T. 64 N., R. 41 W.).

Dr. Samuel Calvin reported finding the remains of a horse, elephant, camel, and a species of the *Hipparion* in 1911.

MGSQV 1037*. **Dallas County** (Sec. 6, T. 34 N., R. 20 W.).

Mastodon finds were made by John M. Wise on his farm at intervals from 1903 to 1933. The site was described as a 5-acre sand bog near the "Loftis Place". The specimens are in the Missouri State Museum.

MGSQV 1038. **Lafayette County.**
In an abandoned bed of the Missouri River at Wellington, elephant and musk-ox remains were reported by Dr. E. Nasse in 1915.

MGSQV 1039*. **Saline County** (NE¼ sec. 36, T. 50 N., R. 19 W.).
Near the right (west) bank of the Missouri River, George P. Purcell, of Arrowrock, reported that he had found a mastodon tooth several years prior to 1924.

MGSQV 1040. **St. Clair County.**
Near Osceola, a mastodon molar was dredged from the bed of the Osage River. The find was reported by Edward Butts to O. P. Hay who published the report in 1924.

MGSQV 1041*. **Lewis County.**
From a gravel pit 2 miles south of La Grange, F. B. Howell (1925) and R. C. Schappler (1930) sent mastodon remains to the Missouri State Museum (Acc. #3161 and #5681, loc. D-C-1 and D-C-12).

MGSQV 1042. **Callaway County.**
At Fulton, a mastodon tooth was found by Jesse Maughs in 1927. It was loaned to the Missouri State Museum (D-C-1).

MGSQV 1043*. **Miller County** (Sec. 12, T. 42 N., R. 14 W.).
Mastodon remains were excavated near the head of an eastern tributary to Brush Creek by Eugene Bond about 1917. They were loaned to the Missouri State Museum (D-C-1).

MGSQV 1044*. **Cass County** (Sec. 35, T. 44 N., R. 33 W.).
About 4 miles southwest of Freeman, mastodon bones and teeth were found and sent to the Missouri State Museum (Acc. #1233/1-5) by Senator C. S. Nelson in 1927 and 1936.

MGSQV 1045. **Montgomery County.**
On the Loutre River 3¼ miles south of Mineola, H. Russel, in 1928 found a mastodon tooth which was sent to the Missouri State Museum (Acc. #2394/1, currently misplaced).

MGSQV 1046. **Nodaway County.**
Near Bernard, mastodon remains were found by Roy Manley in 1931 and earlier. They are said to be at Northwest Missouri State College at Maryville, Missouri.

MGSQV 1047. **St. Louis County.**
A news story in 1931 reported mastodon remains "near St. Louis". They were reportedly sent to Washington University in St. Louis, but they are not recorded there.

MGSQV 1048. **Buchanan County.**
About 4 miles northeast of St. Joseph, mastodon remains were found in 1917 and sent to the University of Kansas.

MGSQV 1049. **Nodaway County.** (NW¼ sec. 32, T. 67 N., R. 35 W.).
On the Will Houston farm, mastodon remains were reported by Raymond Houston of Blanchard, Iowa in 1933 (?).

MGSQV 1050. **Franklin County.**
In the Meramec River gravel at Pacific, Missouri, mastodon remains were reported by Dr. Fletcher in 1933. They are said to be in the State Museum in Jefferson City.

MGSQV 1051. **Gentry County.**
Mastodon remains were reported in a news story to have been found near King City. The find was made by Dr. R. H. Hurst about 1933.

MGSQV 1052. **Jefferson County.**
The mastodon skeletons that were reported in a news story about 1934 are said to have gone to Washington University in St. Louis. The story is confused placing the locality in St. Louis County near its southern tip. Elsewhere Jefferson County is indicated, and the locality is assumed to be about a mile from the abundant finds near Kimmswick.

[MGSQV 1053.] **Perry County.**
In Clump Cave the teeth and footbones of a peccary and the tibia, metatarsal, and tooth of a horse were found by R. D. Oesch in February 1962.

MGSQV 1054. **Jefferson County.**
On Romaine Creek 4 miles south of Fenton, a mastodon jaw with teeth was found in 1934, and it is said to be in Washington University, St. Louis, Missouri.

MGSQV 1055. **Cass County.**
Nine miles south of Harrisonville, mastodon teeth were reported by

Bliss Von Sandt in 1936. They are said to have been sent to Kansas City University and to the University of Kansas.

MGSQV 1056. **Platte County** (NW¼ SE¼ sec. 30, T. 53 N., R. 35 W.).
Four-tenths of a mile north of Beverly, deer and peccary remains were found by Stanley Davis and reported by him in his Ph.D. dissertation in 1955 (Yale University, New Haven, Connecticut).

MGSQV 1057. **Lafayette County.**
Near Higginsville the find of a horse tooth was reported by Elmer Utlaut from his farm with an "associated point". This report was made in the Higginsville paper, *The Advance*, in June 1936.

MGSQV 1058. **Atchison County.**
One mile north of Rockport, a large leg bone, presumably a mastodon find by J. Rundell in 1934 was reported in 1937, by A. V. Volkman, editor.

MGSQV 1059. **Johnson County** (N½ NW¼ sec. 26, T. 48 N., R. 24 W.).
Mastodon remains were reported at this locality by William L. Wolfrum in 1937. They were sent to the Missouri State Museum (#2277-D-C-12).

MGSQV 1060. **St. Charles County.**
On a tributary of Elm Branch, teeth and bone fragments were found by J. W. Ludwig in 1938. They are said to be at Washington University in St. Louis, Missouri. The find is mentioned in the Transactions of the St. Louis Academy of Science, vol. 29, page 222.

MGSQV 1061. **Cole County.**
Along the Osage River, horse teeth were reported by Louis J. King in 1938 and sent to the Missouri State Museum (D-C-7).

MGSQV 1062. **Callaway County.**
On Little Auxvasse Creek, 3½ miles from Tebbetts, a horse sacrum was reported by Calvin Stock in 1939 and sent to the Missouri State Museum (D-C-1).

MGSQV 1063°. **Moniteau County** (Sec. 30, T. 43 N., R. 14 W.).
About a mile southwest of Enon in 1941, Mr. Loyd E. Grimes, then superintendent of the Eldon schools, found many bones during the excavation of an ancient filled sinkhole. The excavation, called the Sullens mine, produced remains of mastodon, elephant, tapir, sloth, horse, turtle, and frog which were recovered by M. G. Mehl, and others in 1942 and later. Specimens are to be found in private collections, the High School at Eldon, the Missouri State Museum (Acc. #2134A/120-151, D-C-12), the University of Missouri (V. P. 666, 667, 668), and the American Museum of Natural History (#39406 and others).

MGSQV 1064. **Jackson County** (Sec. 31, T. 51 N., R. 30 W.).
On Sugar Creek a bison humerus was found about 1915. It was sent to the University of Missouri (V. P. 681).

MGSQV 1065. **Boone County.**
On Hinkson Creek south of Columbia, a mastodon tooth was found by Robert P. Friedman in November 1958. It is in his personal collection.

MGSQV 1066. **Boone County.**
On Cedar Creek 12 miles northeast of Columbia, an elephant tooth which was identified by M. G. Mehl was found by M. M. Maupin in 1955. It is in the private collection of Bruce Walker.

[MGSQV 1067]. **Carroll County.**
On the Bennett Long farm, a horse tooth was found by Donald North about 1935. It is now in the University of Missouri collections (V. P. 663).

MGSQV 1068. **Taney County** (Sec. 23, T. 22 N., R. 22 W.).
At Table Rock Dam, horse teeth were excavated during construction in 1955 and were sent to the University of Missouri by Lue Hicks. They are now in the University collections (V. P. 664).

MGSQV 1069. **Clay County.**
A horse tooth is in the University of Missouri collections (old number 2301). The original label is marked *Equus major.*

MGSQV 1070°. **Boone County** (NE¼ SE¼ sec. 30, T. 48 N., R. 13 W.).
Here in the bed of Perche Creek, at low water in 1949, Mr. Roger G. Miller found an exceptionally large humerus of a mastodon. It is in the University of Missouri collections (V. P. 660).

MGSQV 1071*. **St. Louis County.**

At 13th and Cherokee Street, the site of the old Lemp Brewery in St. Louis, there is a cavern of considerable extent, part of which was once used as a theater and beer garden. Further excavations brought to light a large number of peccary remains. Other finds include armadillo, woodchuck, beaver, porcupine, wolf, bear, raccoon, and deer. Some of the finds are thought to be of recent age. The largest collection of this material is to be found in the American Museum of Natural History under Numbers 45701 to 45747. Specimens are also recorded in the University of Missouri (V. P. 661 and 662). One good skull of a peccary (2425) is to be found in the collections at the Wild Life Laboratory of the University of Missouri.

MGSQV 1072*. **Cooper County** (Sec. 22, T. 46 N., R. 19 W.).

About 14? miles south of Blackwater on the Lamine River, from about 1935 to date, Mr. Phillip Widel has collected bones that have been dredged from the river. These include a tusk about 9 feet long, elephant and mastodon teeth and bones, horse teeth, and part of a musk-ox skull. This latter was figured by Dr. C. D. Holmes in 1949 in his book, "Introduction to College Geology".

MGSQV 1073*. **Atchison County** (SW¼ sec. 25, T. 64 N., R. 41 W.).

On the farm of Mr. Amos Russell, there have been found remains of elephant, mastodon, sloth, bison, elk, deer, and part of the tibia-tarsus (lower leg) of a large bird. The remains were exposed by exceptional gully wash.

MGSQV 1074. **Bates County.**

On a bank of the Marias des Cygne River (regarded by some as the Osage River in Bates County) an artiodactyl jaw with several teeth, presumably bison, was found by Mr. T. H. Hutchinson in 1958. The specimen is in the Wild Life Laboratories collection at the University of Missouri.

MGSQV 1075. **Macon County** (SE¼ NE¼ sec. 17, T. 57 N., R. 14 W.).

In an excavation in Kansan till, a horse femur was found by Mr. Lloyd Schmaltz in 1958. It is in the University of Missouri collections (V. P. 671).

MGSQV 1076. **St. Clair County** (NE¼ sec. 13, T. 37 N., R. 24 W.).

At this locality, a horse tooth is said to have been associated with a "point". The specimen is in the University of Missouri archeological collection.

MGSQV 1077. **Nodaway County.**

In Toad Hollow, northwest of Maryville, a horse tooth was found by Denny and Jim Monticue and Michael Williams in July 1960. It was identified by M. G. Mehl.

MGSQV 1078. **Phelps County.**

In the excavation for the new Electrical Engineering building at the Missouri School of Mines and Metallurgy at Rolla, Missouri, a large number of horse teeth were found. They are now in the University of Missouri collections (V. P. 670).

[MGSQV 1079*]. **Camden County.**

The location of this site is Carroll Cave which is several miles in length. Several long range scientific projects including the search for skeletons are now being carried on in this cavern by Dr. Oscar Hawksley. The remains of a giant wolf have been recovered, associated with beaver remains. One of the more important finds is the humerus of a large extinct bear which was found by Gary Schevers and is now in the collections of the University of Missouri (V. P. 682). The wolf skeleton is at present on loan to the Wild Life Laboratory of the University of Missouri. The beaver remains are recorded in the University of Missouri collections (V. P. 672 and 673).

MGSQV 1080. **Cooper County.**

This locality is on the Lamine River. A woodchuck *(Marmota monax)* was dredged from the river in 1958. It is now in the University of Missouri collections (V. P. 694).

MGSQV 1081. **Audrain County.**

Four and one-half miles south of Benton City, a horse rib was found in a well in July 1912. It is in the University of Missouri collections (V. P. 675).

MGSQV 1082. **Boone County.**

Near Columbia, a horse tooth was found by Charles S. Boulder; date not known. The tooth is in the University of Missouri collections (V. P. 676).

[MGSQV 1083]. **Pulaski County.**

In Bat Cave, peccary and deer remains with a suggested association of pottery were found by Richard Meyers in 1959. These finds are in the University of Missouri collections (V. P. 677). Similar remains in addition to those of a giant wolf and a variety of small mammals have been collected by Dr. O. Hawksley, Jo Blevins, George Deike, and Robert Gerard.

MGSQV 1084. **Phelps County** (SW¼ SW¼ sec. 9, T. 38 N., R. 9 W.).

In Granny Baker Cave, deer and raccoon bones were found by John Bushby in 1958. They are in the University of Missouri collections (V. P. 679).

MGSQV 1085. **Franklin County** (NE¼ sec. 2, T. 40 N., R. 2 W.).

In a cave in Meramec State Park, a large box turtle was collected from a dripstone conglomerate by Richard Meyers in 1958. It is now at Central Missouri State College.

MGSQV 1086. **Callaway County** (SE¼ sec. 32, T. 45 N., R. 11 W.).

A snake, lizard, bat, shrew, etc., are cemented by calcareous tuffa in a crevice high in a quarry face at this locality. Most of the bones seem to be a record of animals fed upon by rattlesnakes.

MGSQV 1087. **Boone County.**

A bison tooth was found by Donna Lackey in December 1959. It is in the University of Missouri Wild Life Laboratory collections.

MGSQV 1088. **Holt County** (SW¼ NE¼ sec. 32, T. 60 N., R. 38 W.).

In the Sangamon soil profile, loess kindchen containing gophers were found by Dr. Wallace B. Howe in March 1959. They are in the University of Missouri collections (V. P. 690).

MGSQV 1089. **Jefferson County** (NW¼ sec. 34, T. 42 N., R. 5 E.).

In Schneider's Cave, raccoon bones were found by Mrs. Hudson in August 1960. They are in the University of Missouri collections (V. P. 689).

MGSQV 1090. **Jefferson County.**

On the farm of Mr. Ray J. Ottomeyer near High Ridge, peccary bones were found by Gregory Yokum in August 1960. They are in the University of Missouri collections (V. P. 691).

[MGSQV 1091*]. **Laclede County.**

There is a pit at this locality, currently being investigated by Dr. Oscar Hawksley, that has produced many bones of bear and smaller mammals. One of the more important finds is the skull and jaws of a primitive extinct peccary. The materials collected are in the collections at Central Missouri State College at Warrensburg, Missouri.

MGSQV 1092. **Platte County** (NW¼ sec. 13, T. 54 N., R. 35 W.).

A horse tooth was found in gumbotil in 1959 by Dr. Wallace B. Howe. It is in the University of Missouri collections (V. P. 692).

[MGSQV 1093]. **Boone County.**

A "bear pit" several miles south of Columbia has yielded skeletons of several black bears. They were found by Dr. William H. Elder and his students. The skeletons are now in the University of Missouri Wild Life Laboratory collections. The work at this locality started in 1954 and has since continued intermittently.

MGSQV 1094. **Cole County** (SW¼ SW¼ sec. 15, and SE¼ NE¼ sec. 29, T. 43 N., R. 11 W.).

At these two locations, mastodon teeth were dredged from the Osage River in 1959. The first was found by J. C. Carland of the Adrian Material Company and the second by C. W. Roweth.

MGSQV 1095. **Johnson County.**

Near Holden, an upper cheek tooth of a horse was found by the son of Mrs. F. M. Meads in 1960.

MGSQV 1096. **Boone County.** (Sec. 10?, T. 51 N., R. 13 W.).

In the bank of a small creek about 4 miles west of Sturgeon, a horse tibia was found in September 1960 by Dick McCarver and Charles Swanson. It is in the University of Missouri collections (V. P. 693).

MGSQV 1097. **Maries County** (Sec. 26, T. 40 N., R. 10 W.).

On the farm of Andrew Buschman in a cornfield off Mo. Hwy. 42, mastodon and bison bones were found by John Streumph and identified by Donald M. Johnson.

MGSQV 1098. **Morgan County** (SE¼ NE¼ sec. 6, T. 41 N., R. 18 W.).

In Jacobs Cave which is 5 miles south of Versailles on Mo. Hwy. 5, peccary bones (about 30 specimens) were found by Mr. Russell Hall in 1954 and identified by Donald M. Johnson.

MGSQV 1099. **Cooper County** (Sec. 15 or 22, T. 46 N., R. 19 W.).

On the Lamine River 14? miles south of Blackwater a horse tooth, left upper molar, and a long piece of elephant tusk was found by Mr. Phillip Widel in 1935.

MGSQV 1100. **Schuyler County** (Sec. 16, T. 66 N., R. 13 W.).

North of Downing, a tooth of a young elephant was found by Derwood Comstock in August 1959.

MGSQV 1101. **Howell County** (NW¼ sec. 21, T. 23 N., R. 10 W.).

In the bottom of a sinkhole on the JWP Ranch of Col. E. L. Jenkins, near Cureall, the proximal end of the left ulna of a mastodon was found by Jerry LaFevers and Bill Gum in August 1960.

MGSQV 1102. **Jefferson County** (Sec. 19, T. 41 N., R. 6 E.).

About 1 mile west of Herculaneum on the north side of Joachim Creek, there is a crevice which was discovered by Col. C. M. Jenni in 1939 and excavated by E. C. Olson and others. Here was discovered fragmentary remains of: turtle, snake, alligator, coyote, wolf, fox, skunk, raccoon, mountain lion, wood rat, field mouse, lemming, squirrel, rabbit, horse, tapir, camel, deer, bison, peccary, and ground sloth. These materials are in Walker Museum at the University of Chicago.

[MGSQV 1103]. **Pulaski County.**

In Cox Cave, fragmentary remains of a giant short-faced cave bear and a large canid (wolf) were found by Garry Schevers April 15, 1961. They are recorded in the University of Missouri collections as V. P. 687 and 686 respectively.

[MGSQV 1104]. **Crawford County.**

In Nameless Cave on the Meramec River bluff south of Sullivan, Mr. Ronald Oesch discovered remains of a large cave bear in June 1961.

MGSQV 1105. **Daviess County** (NW¼ sec. 9, T. 60 N., R. 29 W.).

Southwest of Plattsburg on the Grand River, an elephant tooth was found by Mr. Fred M. Call of Jamesport (date uncertain) and is now in his private collection along with part of a bison skull and horse teeth, possibly from the same place?

MGSQV 1106. **Daviess County** (NW¼? sec. 16, T. 59 N., R. 27 W.).

East of Gallatin on the Grand River. An elephant tooth was found by Mr. Fred M. Call of Jamesport, Missouri and is now in his collection.

MGSQV 1107. **Moniteau County** (Sec. 30, T. 44 N., R. 14 W.).

In a gravel branch 1½ miles north of Russellville and 3 miles west, four Pleistocene horse teeth (upper molars) were found by Miss Louise Wermel in 1959. The area was checked by Grover W. Snead, Vocational Agriculture Instructor in August 1961, and two of the teeth were checked by M. G. Mehl. The specimens are in the private collection of Miss Wermel.

MGSQV 1108. **Knox County.**

Part of a bison skull was found beneath a considerable thickness of gravel on the North Fork of South Fabius River east of La Plata (Macon County) by Mr. Ellis Huling; date not recalled. The skull was described to Mehl in August 1961. It is in the private collection of "Ellice in Wonderland" at La Plata.

MGSQV 1109. **Lafayette County** (Sec. 16, T. 50 N., R. 27 W.).

At this locality Mr. William H. Hiatt (RFD 1, Lexington), found a large, mastodon molar and noted the possibility of more material. Attention was called to the find by Dr. Frank E. Meyer, 235 N. 16th Street, Lexington. Identification was made by M. G. Mehl.

MGSQV 1110. **Platte County** (SE¼ NE¼ sec. 23, T. 51 N., R. 34 W.).

Bison antiquus, parts of two horn cores and other skull fragments, six teeth, the atlas, and five other vertebrae were found by Charles Baker of Kansas City and David Stodden of Parkville in the summer of 1960. The remains were examined by J. M. Shippee of Kansas City in the summer of 1961 and reported by him in the Kansas City Star and a letter to M. G. Mehl.

MGSQV 1111. **Pike County.**

Southeast of Louisiana on Hwy. 79 near Little Calumet Creek, a mastodon tooth was discovered by Dow Morton (deceased, April 1936). The repository is not known. The find was reported in a Louisiana newspaper in November 1961.

MGSQV 1112. **Pike County.**

On Little Buffalo Creek, southwest of Louisiana, a mastodon tooth was discovered by Jackie Carr and Tom Wallace in November 1961. The find was reported in a newspaper from Louisiana in November 1961 and in a letter from Carr to M. G. Mehl.

MGSQV 1113. **Perry County** (NW¼ SE¼ SW¼ Survey 2137, T. 35 N., R. 10 E.).

In Tom Moore Cave a part of a turtle plastron, peccary bones, and a string of connected snake vertebrae were found by Ronald Oesch on March 27, 1961. A single phalanx found here is doubtfully referred to camel.

[MGSQV 1114]. **Boone County.**

A cave in southern Boone County. During the spring of 1962 four students in the University of Missouri, Pete O'Mara, Gary Simon, Jack Stewart, and John Trage, began excavating this small cave. Among the finds have been identified many peccary bones and teeth, several jaws of Pleistocene beavers, teeth and foot bones of the extinct "Dire wolf", and numerous bones of deer, some thought to be Pleistocene in age.

COUNTY DISTRIBUTION OF VERTEBRATE LOCALITIES

Atchison. MGSQV 1036, 1058, 1073.

Audrain. MGSQV 1081.

Bates. MGSQV 1018, 1022, 1074.

Benton. MGSQV 1006, 1013.

Boone. MGSQV 1015, 1065, 1066, 1070, 1082, 1087, 1093, 1096, 1114.

Buchanan. MGSQV 1032, 1048.

Caldwell. MGSQV 1026.

Callaway. MGSQV 1042, 1062, 1086.

Camden. MGSQV 1079.

Cape Girardeau. MGSQV 1025.

Carroll. MGSQV 1067.

Cass. MGSQV 1019, 1031, 1044, 1055.

Clay. MGSQV 1069.

Cole. MGSQV 1061, 1094.

Cooper. MGSQV 1072, 1080, 1099.

Crawford. MGSQV 1104.

Dallas. MGSQV 1037.

Davies. MGSQV 1105, 1106.

Franklin. MGSQV 1050, 1085.

Gasconade. MGSQV 1004.

Gentry. MGSQV 1051.

Greene. MGSQV 1011, 1012, 1033.

Hickory. MGSQV 1001.

Holt. MGSQV 1088.

Howard. MGSQV 1015.

Howell. MGSQV 1101.

Iron. MGSQV 1008.

Jackson. MGSQV 1028, 1029, 1034, 1035, 1064.

Jasper. MGSQV 1009.

Jefferson. MGSQV 1005, 1052, 1054, 1089, 1090, 1102.

Johnson. MGSQV 1059, 1095.

Knox. MGSQV 1108.

Laclede. MGSQV 1091.

Lafayette. MGSQV 1038, 1057, 1109.

Lewis. MGSQV 1041.

Macon. MGSQV 1075.

Maries. MGSQV 1097.

Miller. MGSQV 1043.

Moniteau. MGSQV 1063, 1107.

Montgomery. MGSQV 1045.

Morgan. MGSQV 1098.

New Madrid. MGSQV 1002, 1003.

Nodaway. MGSQV 1046, 1049, 1077.

Perry. MGSQV 1053, 1113.

Pettis. MGSQV 1024.

Phelps. MGSQV 1078, 1084.

Pike. MGSQV 1023, 1111, 1112.

Platte. MGSQV 1030, 1056, 1092, 1110.

Pulaski. MGSQV 1083, 1103.

St. Charles. MGSQV 1060.

St. Clair. MGSQV 1040, 1076.

Ste. Genevieve. MGSQV 1020.

St. Louis. MGSQV 1014, 1016, 1017, 1047, 1071.

Saline. MGSQV 1021, 1039.

Schuyler. MGSQV 1100.

Scotland. MGSQV 1007.

Stone. MGSQV 1010.

Taney. MGSQV 1068.

Washington. MGSQV 1027.

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