Fossils of Arkansas

An Introduction to Paleontology Illustrated With Common Fossils of Arkansas

By

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Dedicated to HUGH D. MISER,
who blazed the trail for
Arkansas geologists.

PREFACE

This book was written in an attempt to answer some of the many questions commonly asked about fossils of Arkansas. Certainly no single publication could cover this subject fully, but it is hoped that reading *Fossils of Arkansas* will be a step toward understanding the paleontology of this state and that this will serve as a stimulus and guide in the reader's search for additional information.

The aim has not been to catalog all of the fossils of the state, nor to treat the subject of paleontology fully. Instead, this book is designed to (1) acquaint the non-scientist with some of the broad aspects of paleontology, (2) illustrate the general geology of Arkansas, (3) illustrate and identify some of the more common fossils of Arkansas, and (4) list some of the convenient collecting localities in the state.

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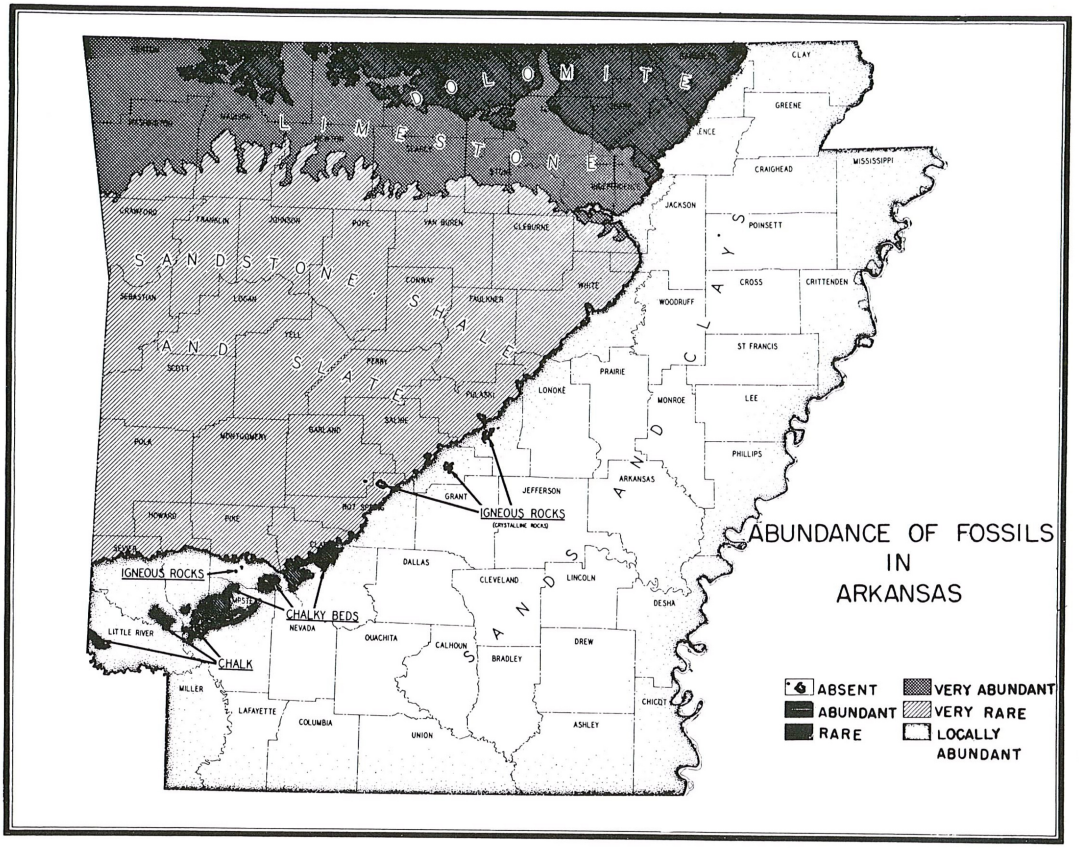
DOLOMITE
LIMESTONE
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CLAY
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LEE
PHILLIPS
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(CRYSTALLINE ROCKS)
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CALHOUN
OUACHITA
NEVADA
CHALKY BEDS
IGNEOUS ROCKS
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LITTLE RIVER
MILLER
LAFAYETTE
COLUMBIA
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VERY RARE
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INTRODUCTION

Paleontology: Its Meaning and History

Biology, the study of all living things, can be subdivided into several allied subjects (Figure 1). One of these, paleontology, is the study of *past* life, the records of which we call fossils. Originally the term "fossil" (from Latin *fossilis,* meaning something dug up) referred to many different naturally occurring objects. For example, the "fossils" described by Agricola in his "De Natura Fossilium" of 1546 were *minerals.* Today, however, the term "fossil" is restricted to objects of organic origin; more specifically, a fossil is *a naturally preserved record that reflects the form and structure of an organism.* The term suggests a pre-historic age, but a precise definition in terms of years would be both artificial and unnecessary. The group of organisms represented by a particular fossil need not be extinct, although many are.

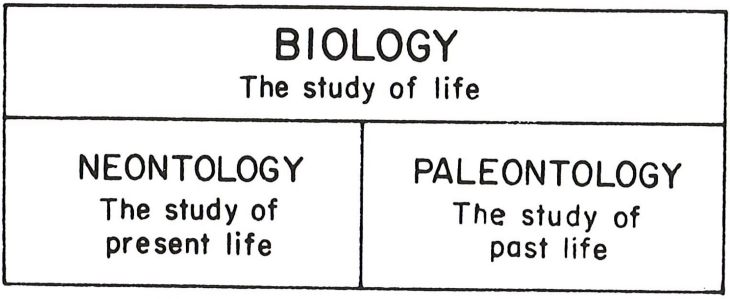


Figure 1. Major subdivisions of biology.

As early as 450 B.C. Herodotus in his African travels observed fossil sea shells in the Libyan desert and correctly inferred that the Mediterranean Sea once extended much farther southward. With this notable exception, however, fancy and mysticism were associated with fossils for many years. Aristotle (350 B.C.) believed that fossils actually *grew* in rocks, and his influence, coupled with religious dogma, effectively suppressed objective thought concerning fossils. It was not until the Renaissance and the advent of the natural sciences that there was a climate conducive to a true understanding of fossils, and by about 1800 their organic nature was universally recognized.

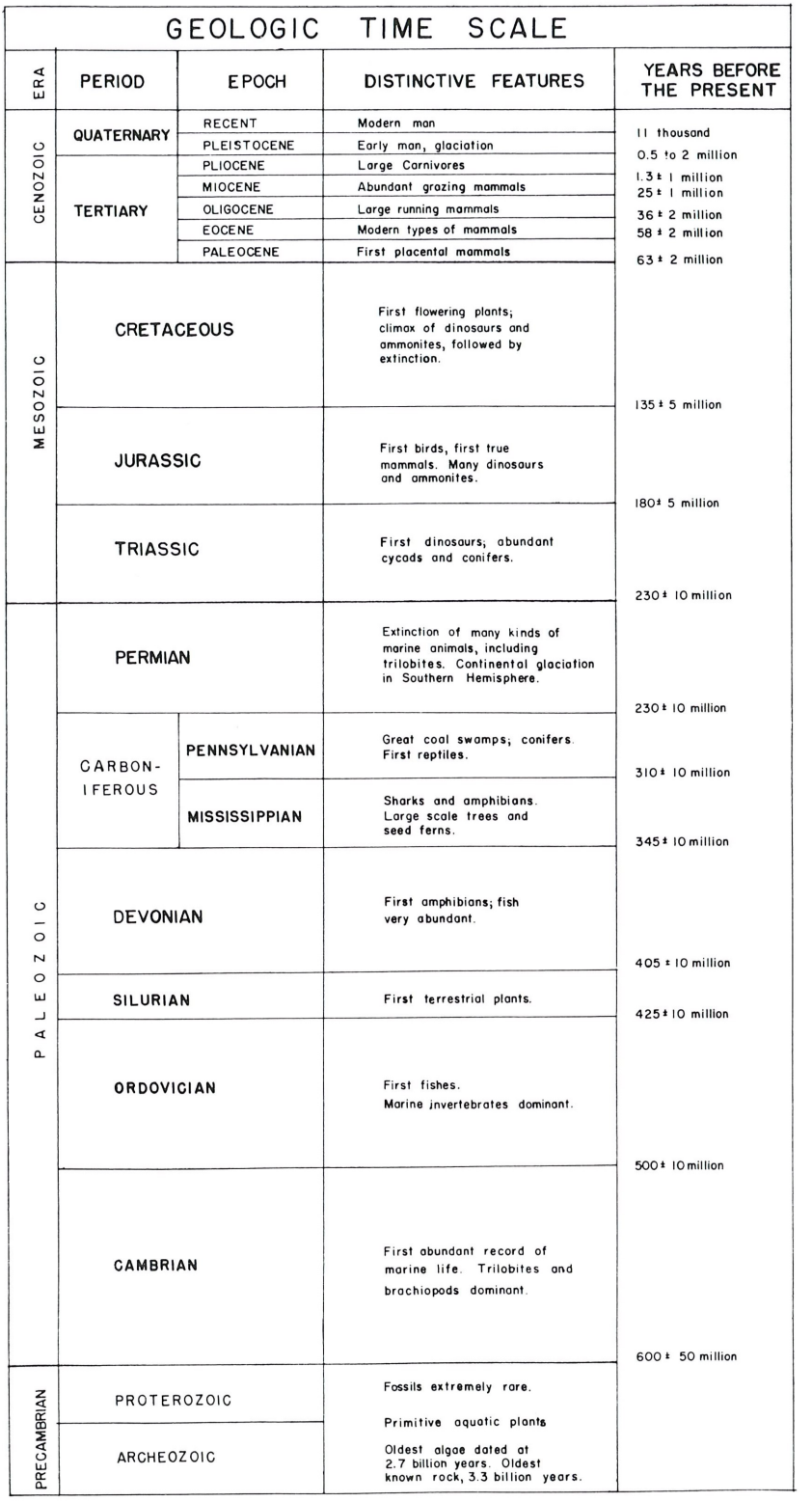


Figure 2. The Geologic Time Scale. (By permission from Zumberge, James H., Elements of Geology, John Wiley and Sons, Inc., New York, 1963.)

Uses of Fossils

The distribution of organisms through time, recorded by fossils, is the basis of our geologic time-scale (Figure 2). Whereas our calendar is based on movements of the earth and moon, the geologic calendar is punctuated by appearances and extinctions of various organisms (Figure 3). Because organisms have changed through time, we are able to subdivide rock sequences into small parts, each of which can be identified elsewhere by the presence of particular fossils (Figure 4). Fossils are therefore useful in tracing strata (rock layers) and continue to be of great importance in working out earth history and exploring for oil, gas, and minerals, in Arkansas.

In addition to illuminating the age of a particular rock formation, fossils also tell us something about the conditions under which the formation was deposited. For example, the Everton, Joachim, and Plattin formations of northern Arkansas have abundant algal deposits like those shown in Plate XII, Figure 3. These deposits tell us that these formations were deposited in water sufficiently shallow for the penetration of light, which is necessary for plant (algae) life.

Some paleontologists are concerned with the relationships among different fossils (prey-predator, etc.). This study, together with a consideration of their physical environment, is called *paleoecology.*

One of the most important things about fossils is that they record the gradual changes that have occurred within plants and animals. Developmental histories (phylogenies) of some groups, for example the horse (Figure 5), are so well documented that progressive development of new forms from older forms is inescapable.

In structurally complex areas (like the Ouachita Mts.), formations are commonly overturned. In such cases, fossils can sometimes aid in determining original tops and bottoms of beds. For example, growth positions of many sessile (attached) organisms are known, and where they are preserved in such positions, orienting the enclosing rocks is made possible (Figure 6). Even in cases where organisms have been strewn about by waves and currents before burial they can in some instances indicate the tops and bottoms of beds (Figure 6, d).

Our principle fuels produced in Arkansas, certainly coal and probably petroleum, are of organic origin and are "fossiliferous" in the broadest sense.

Although fossils are important in all of the ways outlined above, paleontology, the tracing of life history through the geologic past, is a highly rewarding science, and need not be justified in terms of practical application.

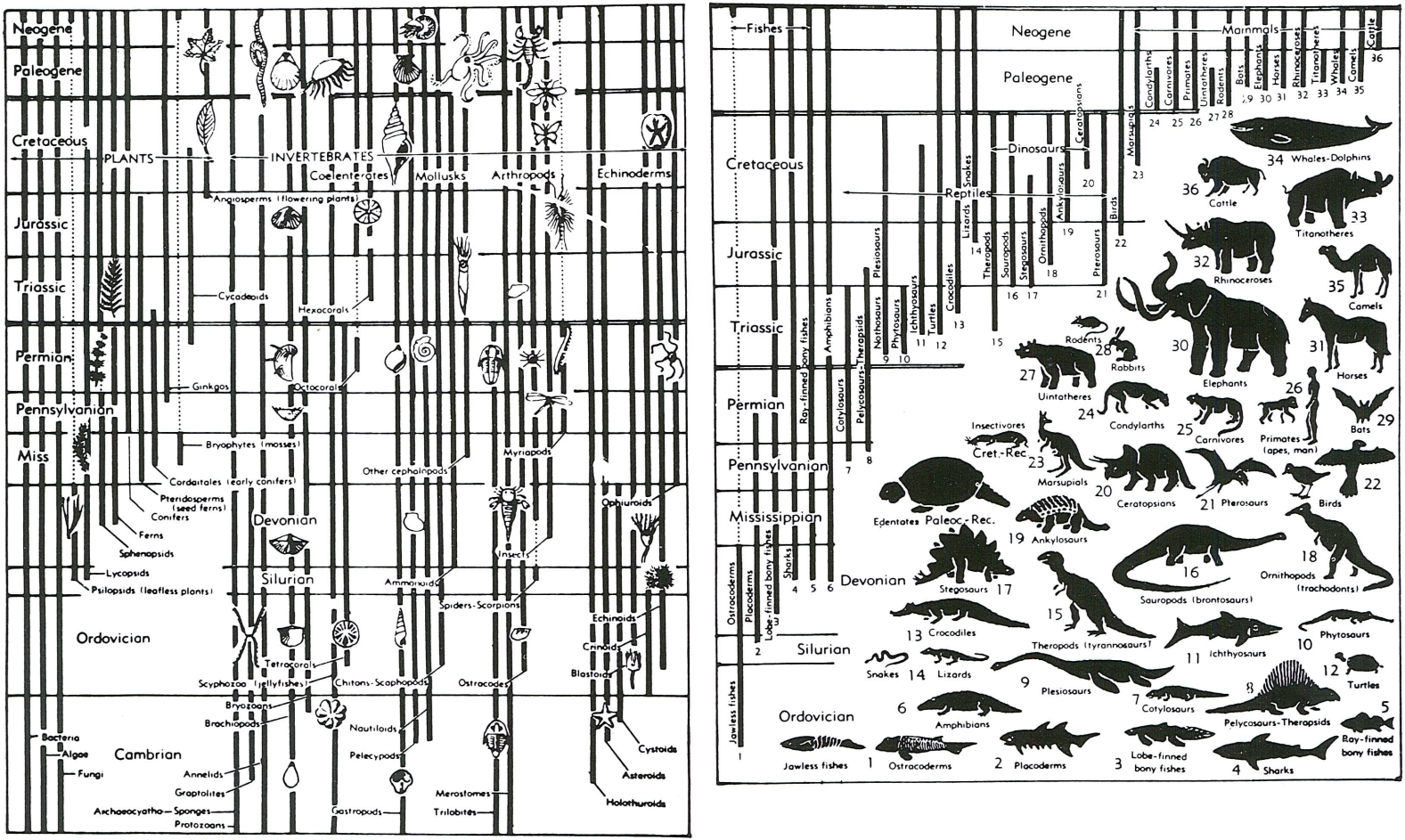


Figure 3. Geologic distribution of life forms. (By permission from R. C. Moore and Geotimes).

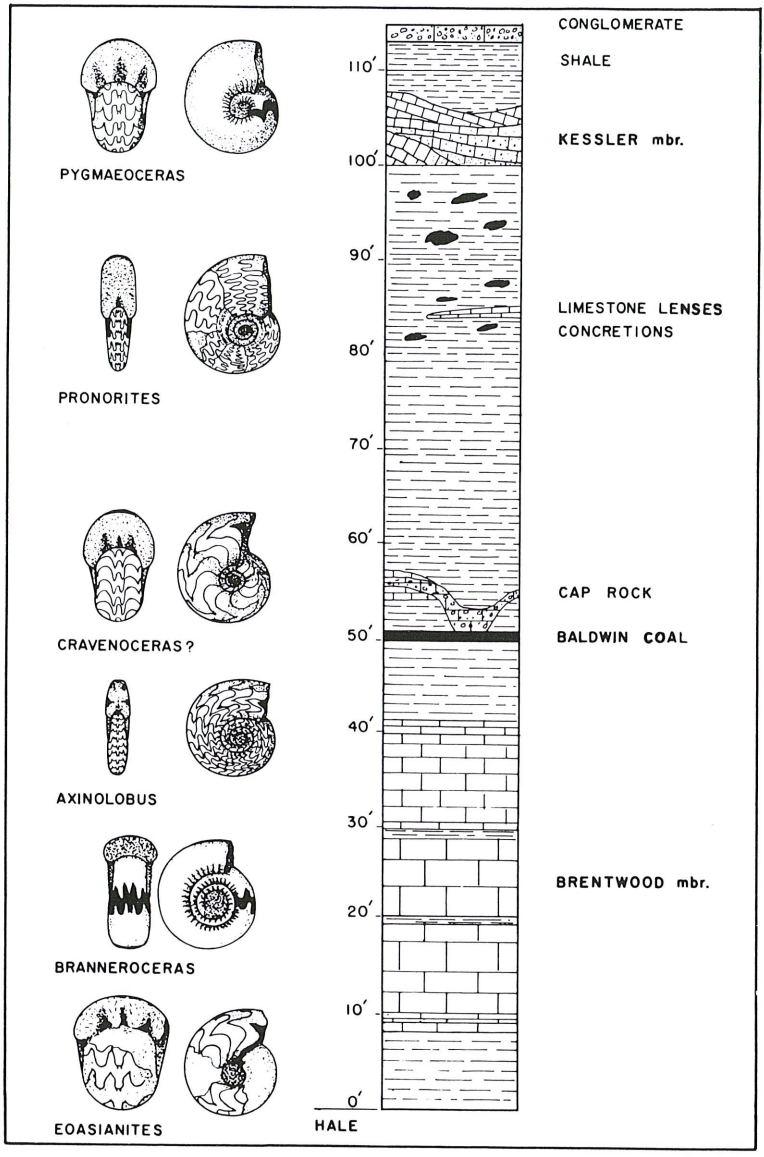


Figure 4. Diagram showing positions of different cephalopods in Pennsylvanian rocks of Washington County. (Modified from Quinn, 1962.)

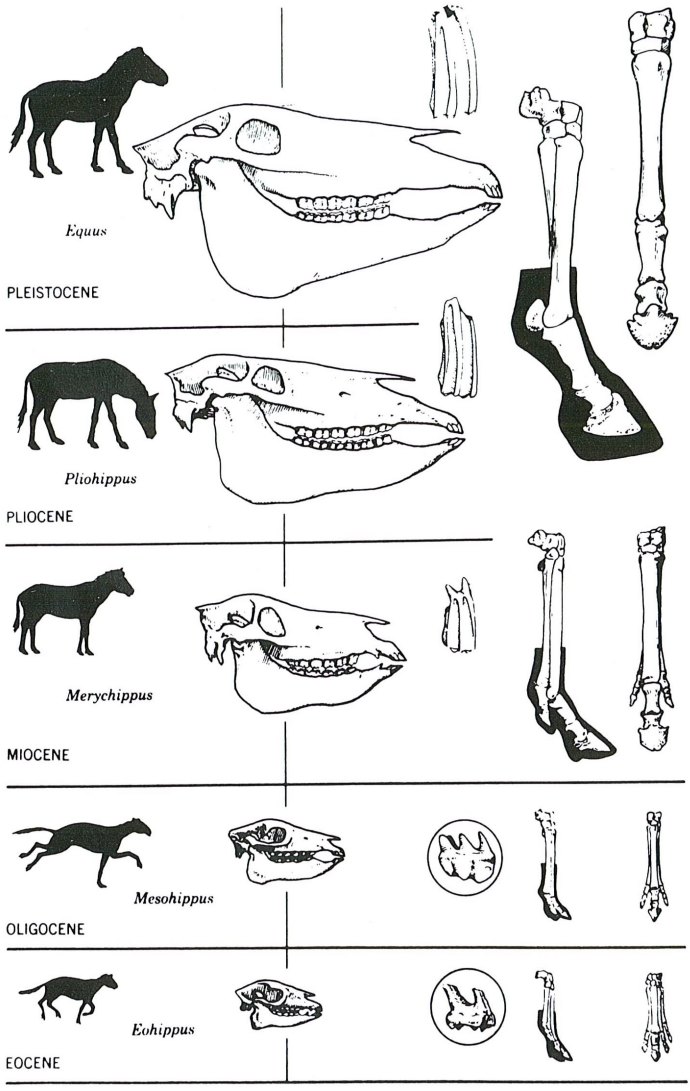
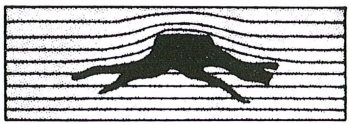


Figure 5. Progressive changes in horses during the Cenozoic Era. (By permission from Zumberge, James H., Elements of Geology, John Wiley and Sons, Inc., New York, 1963.)

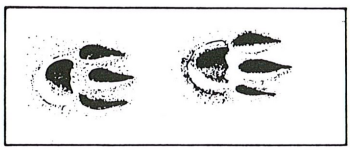
Gastropods. In vermetids and similar worm-gastropods the final feeding tube (as well as scars of early stages) generally points upward during the life of the animal.



Roots. Roots of plants (trees), which are buried in their original upright position, branch out downward.



Animal tracks. Animal tracks on originally soft mud or sand leave impressions (which may penetrate downward through several laminae of mud or sand.)



d). Disjointed or spread-out open valves of **convex pelecypods** are generally brought to rest by wave action or by currents with their convex side up. Exceptions to this rule are not uncommon. Observations based on a single shell or only a few shells are not 100% reliable.

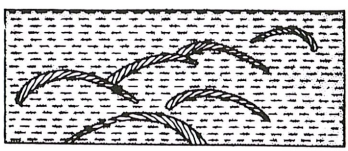


Figure 6. Ways in which fossils can be used for determining tops of beds. (From Muller, 1958.)

PRESERVATION

Concerning preservation, fossils can be grouped into two broad categories, unaltered remains and altered remains.

Unaltered Remains

Unaltered remains, those fossils in which the original chemical and physical structure is essentially unchanged, are further subdivided into unaltered *soft* parts and unaltered *hard* parts.

Soft parts, as might be expected, require unique conditions for their preservation. Desert environments are in some cases characterized by little or no bacterial activity and account for the American Indian "mummies" of the southwest States. Preserved soft parts have also been reported from asphaltic bogs, which are similarly antiseptic. Of considerable fame are the frozen mammoths of Siberia. These beasts, in "cold storage" for thousands of years, are so well preserved that their flesh is edible.

Hard parts (shells, bones, and teeth), though certainly more durable than soft parts, are not immune from postmortem alteration and require conditions favorable, if not unique, for preservation.

Altered Remains

Altered remains are those in which there has been subtraction, rearrangement, or substitution of material by one or more of the following processes:

Carbonization—Carbonization is the leaking away from an organism of liquids and gases so as to produce a carbon residue. Minute details are often preserved, and carbonized leaf impressions in Pennsylvanian and Tertiary rocks of Arkansas are a common example.

Replacement—This is a poorly understood process whereby the original mineral material in the fossil is replaced by a different mineral material. Commonly this involves the replacement of calcite by either pyrite, silica, limonite, or colophane. In some cases details of structure can be extraordinarily well preserved.

Cephalopods in shales of the Fayetteville formation have been replaced by pyrite ("fools' gold"), and one is illustrated in Plate VII, Figure 3. Brachipods replaced by silica dioxide can be found in limestones of the Fayetteville formation; one is illustrated in Plate IV, Figure 3.

Molds

In addition to the organic object (be it altered or unaltered), impressions of organic objects that reflect their form and structure are also included under our definition of "fossil".

A mold is simply an impression or imprint of an organism and can be either an *internal mold* or an *external mold* (Figure 7). Molds of hard parts originally made of calcite commonly occur in chert (flint-rock) and sandstone because water seeping through these rocks, in contrast to that flowing through limestone, is usually low in calcium and tends to dissolve hard parts made of calcite. An internal mold of a brachipod from sandstone in the Clifty formation is shown in Plate IV, Figure 9.

In addition, tracks and trails (actually external molds of sorts), when reflecting the form and structure of the organism, are also considered fossils. Trails are very common in the Batesville sandstone, which crops out along the highway between Mt. View and Leslie.

Pseudofossils

Under "pseudofossils" fall all those curious objects sufficiently systematic in their plan and design so as to suggest an organic origin. Several of the more common types are illustrated in Figure 8.

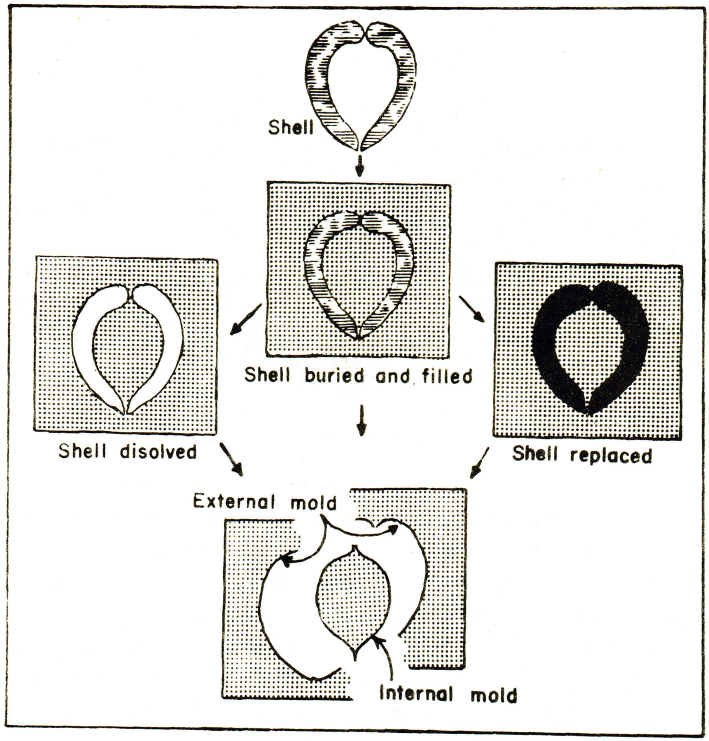


Figure 7. Diagram showing development of molds.

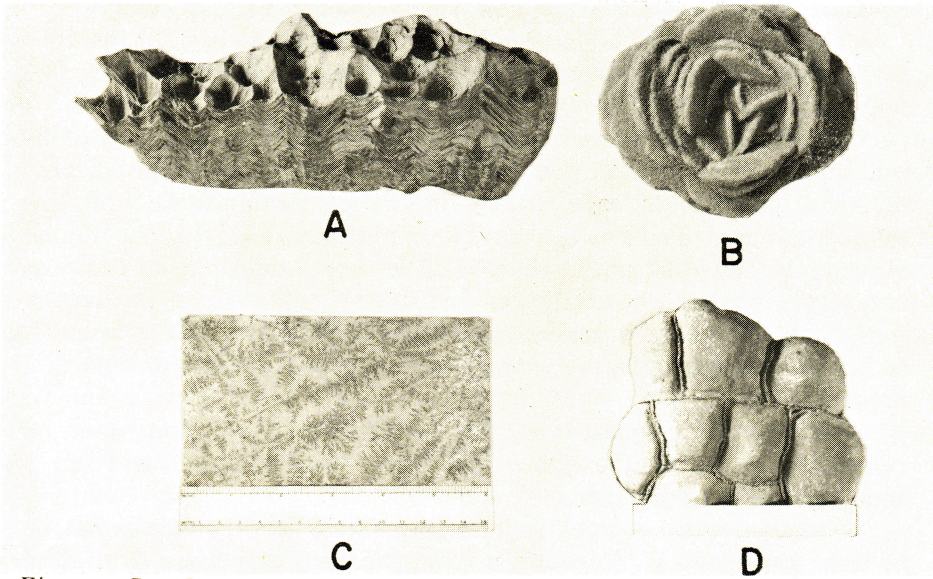


Figure 8. Pseudofossils. A, cone-in-cone structure—a compaction feature. B, a "barite rose" in sandstone—a habit of the mineral barite. C, dendrites—a habit of manganese oxide. D, concretion—developed through concentration of such things as calcium carbonate in shale.

TECHNIQUES

Professional techniques are far too intricate and personal (not necessarily complicated) for presentation here. Furthermore, many techniques, gained only through direct association with experienced workers, are difficult to describe. Therefore this presentation is necessarily abbreviated and oversimplified.

Techniques employed in collecting, preparing, and cataloging fossils differ, depending upon the particular type of fossil material under study. For more information concerning techniques applicable to specific groups of fossils, the reader should consult an experienced paleontologist.

Collecting

The importance of knowing the exact field location of a fossil cannot be over emphasized. The location includes both the geographic location and the name of the formation from which the fossil was collected. The geographic location can be most conveniently and accurately recorded on a county map; the formation name will usually be less easily determined. A brief description of the rock (sandstone, limestone, etc.; color, bed thickness, etc.) might aid a geologist in identifying the formation for the collector via letter or telephone. If the fossil proves to be of scientific importance, exact location must be confirmed in the field by a qualified geologist.

The fossil should be labeled, or put in a labeled bag, in the field, and a record of its number and location should be entered into a field notebook. Do not trust your memory later!

The numbering system should be designed to fit the needs of the individual. As an example, the collector can arbitrarily assign a different number to each county in his particular state and then number successive collecting localities within each county. The number of a particular fossil might then be 14-3, the 14 designating the number of the county and the 3 designating the number of the locality in that county. If the individual has occasion to collect in several states, he can assign each a number with which he can prefix the county-locality notation.

The above is only an example. Feel free to design your own, but remember, any effective system should be (1) systematic and (2) as communicative as possible.

Fossils are sometimes found lying loose, having weathered out of their parent rock. More often, however, they are encased in either "hard" or "soft" rock. "Hard" rock, such as limestone or tightly cemented sandstone, requires the breaking-out of fossils with a hammer and chisel. In some cases fossils will break clean and literally

fall free when the rock is cracked open. Others, tightly cemented to the enclosing rock, must be collected along with adjoining rock matrix and taken into the laboratory where they are painstakingly cleaned. Excess rock should be trimmed away in the field in order to facilitate handling, but care should be taken so as not to damage the fossil. "Soft" rock, such as clay shale, is much more easily searched and in some cases yields a great number of fossils in a very short time. A small spade or entrenching tool is handy for exposing fresh material in situations were weathering has damaged near-surface specimens.

When collecting microfossils[1], it is necessary to have a magnifying lens. Lenses of about 10 power prove best for such work and range in price from about one to ten dollars.

Microfossils can in some instances be detected in the field and thus direct the course of collecting. In other cases they go unnoticed in the field but samples are commonly taken in hopes of yielding them through various laboratory techniques. Such samples can be taken at certain intervals within a rock outcrop, or a continuous "scoop" upward through the outcrop can be made. The latter, called a channel sample, reduces the chance of missing fossils with spotty distribution. Care should be taken when handling microfossils so as to prevent contamination among samples. A little fossiliferous "dirt" from one sample can easily find its way into another, and if this is allowed to happen, serious errors are introduced in studies where exact location of fossils is important.

Larger fossils should be wrapped in tissue to prevent damage in transport.

Thus far, I have dealt only with invertebrate fossils. The vertebrates (animals with backbones) are in a category by themselves as concerns field collecting, and elaborate measures are taken to safeguard their condition. Bones commonly deteriorate upon exposure to the atmosphere, and as the collector progressively exhumes a specimen he must continually cover the exposed parts. The standard procedure is to first apply a layer of wet newspapers, which in turn is covered with cloth impregnated with plaster of Paris. In cases of large specimens, wooden crates must be fashioned to insure safe transport. In the laboratory, the newspapers and plaster are removed and a coat of shellac is applied. Some of the larger and more complete specimens in our museums represent the concentrated efforts of numerous scientists working over periods of many months.

An amateur collector who finds partially exposed bone should exercise extreme care in determining the nature of the fossil. If the fossil promises to be the complete, or nearly complete, remains

[1]Fossils so small that they cannot be studied with the unaided eye.

of a vertebrate animal he should seek the advice of a professional collector.

The amateur collector will sometimes be confused by recently deceased vertebrates. A fairly reliable test, though not conclusive, is to expose the bone to a flame. A foul odor usually indicates Recent, rather than fossil, material.

The collector will occasionally find rather obscure fragments of bone. Although such fragments are interesting and should prompt further searching, certain bones are essential for the classification of their parent organism. These differ, depending upon the particular group of vertebrates, but generally speaking ribs are of little or no use; precise classification of fish requires a skull; amphibians, a backbone; reptiles, the back of the skull; mammals, molar teeth and, for some, feet and horns. Articular surfaces of limb bones are important but fragments are not. Vertebrae (backbones) are of little use for classification within the mammals.

Preparing

Macrofossils[2] enclosed in "hard" rock can be liberated with small inexpensive vibrating and grinding tools (Figure 9). Some knowledge of the morphology (form and structure) of the fossil is necessary for effective grinding and chipping, and the better the preparator's understanding of the fossil, the less likely the possibility of his damaging it.

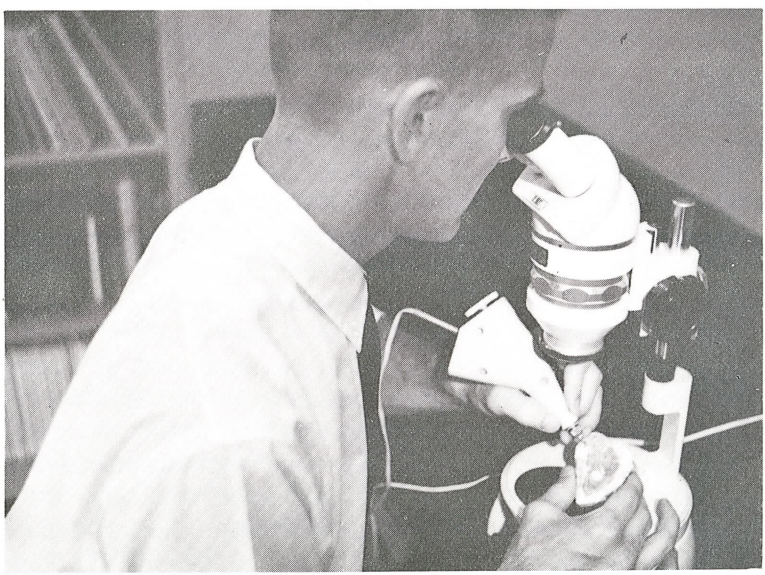


Figure 9. Cleaning a trilobite from St. Clair limestone with a vibrating tool.

[2]Fossils sufficiently large to be seen and studied with the unaided eye.

Certain fossils can be freed from limestone with acids. Phosphatic fossils can be liberated with acetic acid, and fossils that have been replaced by silica, pyrite, etc. can be liberated with hydrochloric acid (Figure 10). Both of these acids are sold commercially, and less expensive grades do just as well as reagent grades.

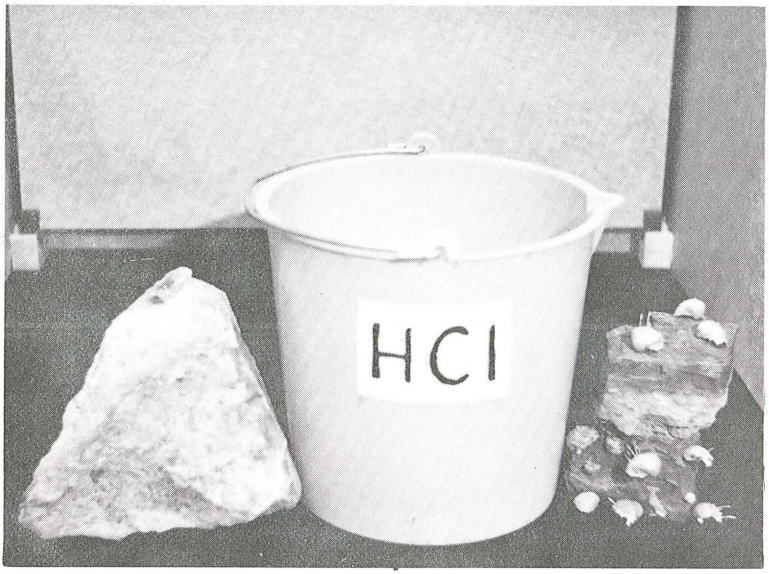


Figure 10. A "before-and-after" picture of Fayetteville limestone from 10 miles east of Leslie. The hydrochloric acid (HCl) dissolves the limestone but not the silicified brachiopods.

Concerning "soft" rocks, some clay shales (principally gray, green, and red shales) can be disagregated by first soaking them in gasoline for several hours followed immediately by soaking them in water to which a little detergent has been added. As the water displaces the gasoline the shale is reduced to a sludge. Some shales can be broken down by simply boiling them in water.

Macrofossils are handled with the fingers, but microfossils are usually picked out of a disagregated sample with a moistened fine (#00) camel hair brush. Several types of slides, designed specifically for mounting and storing of microfossils, are available (Figure 11). Microfossils should be fixed to the slide with water-soluble glue to facilitate later repositioning when necessary.

Some fossils, such as certain foraminifers, bryozoans, corals, and calcareous algae, are studied in thin-sections made in the following manner: The specimen, usually enclosed in limestone, is first slabbed as thin as possible with a rock saw. One side of the slab is then smoothed by grinding with #600 carborundum grit on a glass plate

and cemented to a glass slide with lakeside #70 cement. The slab is then ground sufficiently thin to transmit light (preferably .05-.10mm thick), finished with #600 grit, and covered with a glass cover-slip cemented with canada balsam. Canada balsam requires less heating than does lakeside cement and can therefore be applied without disturbing the lakeside bond between the specimen and the glass slide. The thin-section can then be studied with a transmitted-light microscope.

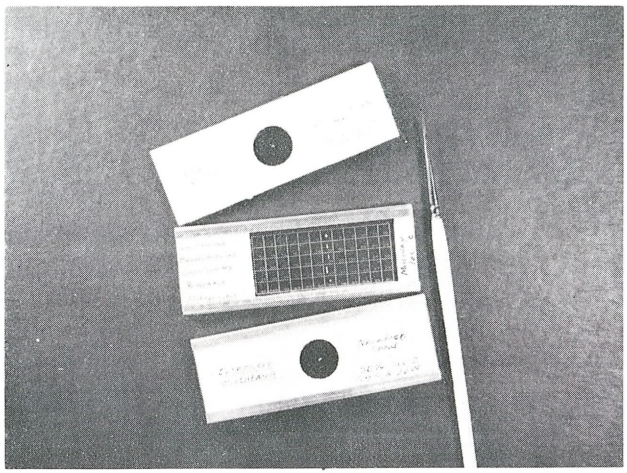


Figure 11. Various slides for mounting microfossils.

An effect similar to that of a thin-section can be achieved much easier by "peeling" the specimen: After sawing the specimen, the sawed surface is smoothed with grinding powder (finishing with #600), etched lightly in dilute hydrochloric acid (to bring out the fabric), and flushed with water. After drying, the specimen is flooded with acetone and a piece of acetate[3] is applied. Because acetate is soluble in acetone, the side in contact with the specimen softens and a mold of the specimen's fabric is produced. When dry, the acetate is peeled off and promptly mounted between 2″ x 2″ glass slides. The peel can then be studied with a transmitted-light microscope, projected on a screen with a slide projector, or "printed" in an enlarger like a piece of film.

A thorough understanding of the internal structure of a fossil requires systematic slicing of the fossil into thin slabs from which the internal structure can be mentally reconstructed in three-dimension. This technique is called serial sectioning. Many fossils are too small for slabbing on a conventional saw. In such cases the fossil is ground on a glass plate and at regular intervals the internal struc-

[3]Kodapak 0075 works best for this. It is available at camera supply houses.

ture is sketched, photographed, or "peeled". The resultant series of illustrations substitutes for a series of thin slabs. The ontogeny (growth history) of a single horn coral, for example, is studied in this manner (Figure 12).

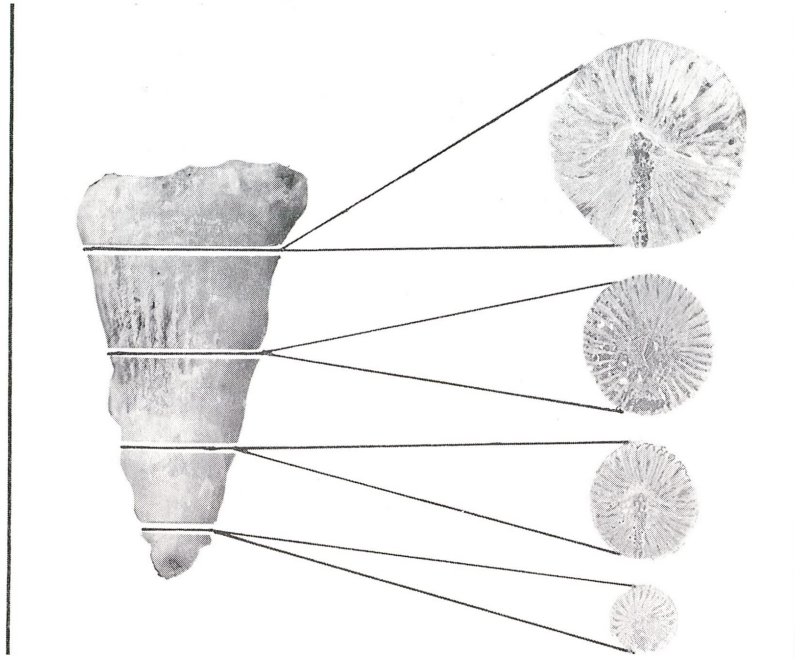


Figure 12. Serial sections of a solitary coral from Boone limestone south of Western Grove. The radial partitions (septa) change in number and shape with growth.

Labeling and Storing

Labeling is of course important when storing fossils. When the size of the fossil permits, a number should be affixed directly on the specimen. This can best be done by first applying a dab of paint, allowing that to dry, and then affixing the number with india ink. Clear shellac can then be applied over the ink for added protection.

Smaller fossils should be placed in an appropriately labeled bottle or lidded box.

Cardboard trays are available in several sizes, and specimens should be stored in such trays along with information concerning location, etc. (Figure 13). A small amount of cotton or tissue should line boxes containing delicate fossils.

Complete lines of storage equipment, designed to fit almost any need, are available from manufacturers. In addition to standard drawer-type cabinets, special trays are available for storing microfossil slides, thin-sections, and acetate peels.

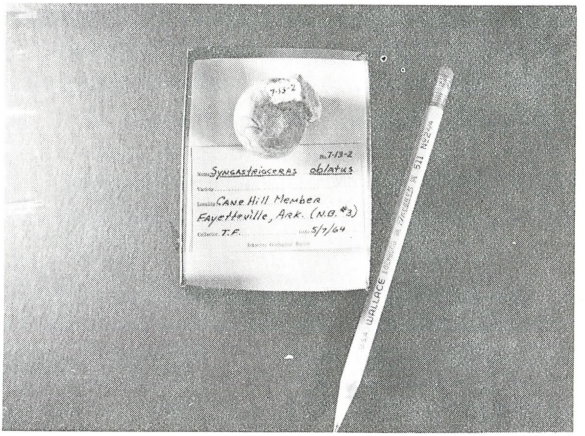


Figure 13. A cephalopod, from the Cane Hill member of the Hale formation, properly numbered and labeled.

Storing, like labeling, should be systematic so that specimens can be found easily. A catalog listing the names and numbers of fossils, along with their drawer numbers, will help to locate fossils quickly.

CLASSIFICATION

History and Aims

Marshalling of paleontologic data and communication of ideas on the subject require classification of fossils, and the science of classifications is called *toxonomy*. The system used, in both paleontology and neontology, was instituted in 1758 by Linnaeus. In his book, *Systema Naturae,* he proposed the so-called binomial system of nomenclature whereby each species would be designated by *two* names: (1) the first name, italicised and capitalized, designates the genus to which the species belongs, and (2) the second name, italicised but not capitalized, designates the particular species within that genus. The second, or "species name", is not sufficient when used alone because many different genera have "species names" in common (just as different states have certain county names in common).

Hopefully, a biologic classification expresses the natural relationships among organisms. For example it is intended that a genus include species all of which share a common phyletic origin; that is, they all were derived from a common stock or the same evolutionary line. Such relationships can best be illustrated by the familiar "family tree". In order to express the natural relationships among fossils, their history of development must be traced. This has been attempted with different degrees of success in many groups.

System Presented Here

The taxonomic heirarchy of organisms consists of seven general categories. These are analogous to regiments, battalions, companies, etc. in an army; the farther down the taxonomic heirarchy, the less inclusive the category. As an example, a common fossil from the Brownstown Marl in Arkansas is classified along with man for comparison.

KINGDOM	—	Animalia	—	Animalia
PHYLUM	—	Mollusca	—	Chordata
CLASS	—	Pelecypoda	—	Mammalia
ORDER	—	Anisomyaria	—	Primate
FAMILY	—	Ostreidae	—	Hominidae
GENUS	—	*Exogyra*	—	*Homo*
SPECIES	—	*ponderosa*	—	*sapiens*
INDIVIDUAL	—	Specimen from the Brownstown Marl on the Ashdown-Ben Lomond Road, 2 miles north of Little River, Sevier County, Arkansas	—	John Doe

Identifications of fossils in this book are made at the genus level rather than at the species level because (1) genus names are adequate for such a general survey, and (2) assignment of species names to many of these specimens should await up-to-date and thorough taxonomic studies.

GEOLOGY

Arkansas can be subdivided into four physiographic provinces each of which coincides with a particular geologic province (Figure 14). The state is endowed with surface rocks that range in age from Ordovician (or possibly Cambrian[4]) to Recent. The only systems not represented at the surface are the Permian, Triassic, and Jurassic (the Jurassic is known from the subsurface).

Paleozoic rocks crop out over the northwestern half of the State and occur in three different provinces: (1) the Ozark Region, with its gently tilted high-carbonate section of rocks; (2) the Arkansas Valley, with its folded and faulted sandstones and shales; and (3) the Ouachita Mountains, with their intensely folded and faulted sand-

[4]The oldest formation in the Ouachita Mountains, the Collier Shale, might be either Cambrian or Ordovician. No fossils have been found in this formation.

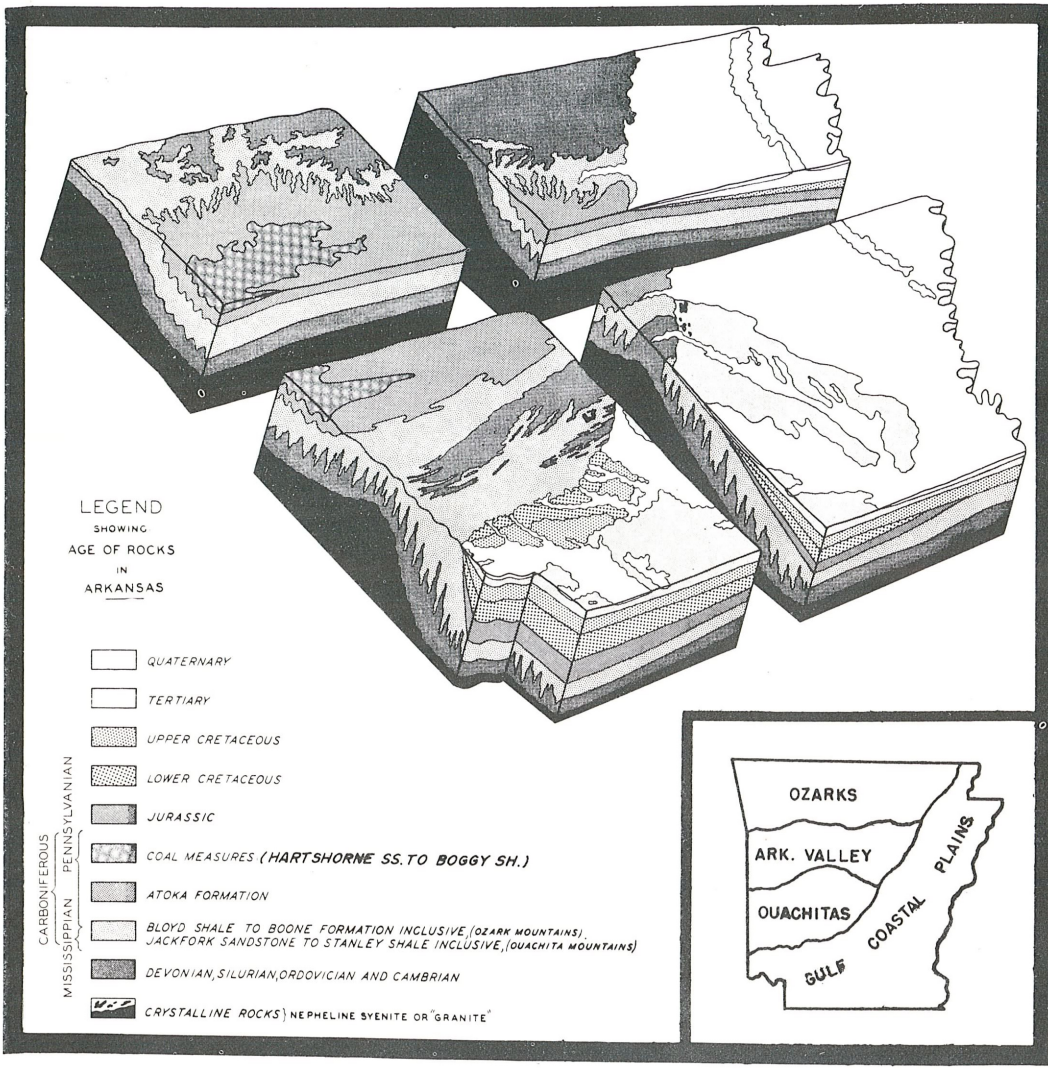


Figure 14. Block diagram showing distribution of rocks of different ages, and inset map showing physiographic provinces.

stones, shales, slates, and cherts. Ozark rocks are so different from Ouachita rocks of the same age that separate nomenclatures are necessary (Figure 15).

Mesozoic and Cenozoic rocks underlie the Gulf Coastal Plain which, in contrast to the other provinces, is characterized by low physiographic relief. Gently tilted formations, much younger than the episode of late Paleozoic mountain building, reflect only the broad sinking of the Gulf region to the south.

All of these rocks are sedimentary in origin and are therefore potentially fossiliferous. Igneous rocks, which make up less than one per cent of the surface rocks of Arkansas, were derived from once-molten rock, which prevents their being fossiliferous.

SURFACE

PALEOZOIC ROCKS IN THE OZARK, ARKANSAS VALLEY, AND OUACHITA MOUNTAIN REGIONS, ARKANSAS

	OZARK-ARKANSAS VALLEY SECTION		OUACHITA MTN. SECTION	
PENNSYLVANIAN	Boggy fm.		(Missing)	
	Savanna fm.			
	McAlester fm.			
	Hartshorne ss.			
	Atoka fm.		Atoka fm.	
	Bloyd sh.	Kessler ls. mbr.	Johns Valley sh.	
		Woolsey mbr.		
		Brentwood ls. mbr.		
	Hale fm.	Prarie Grove mbr.		
		Cane Hill mbr.		
MISSISSIPPIAN	Pitkin ls.			
	Fayetteville sh.		Jackfork ss.	
		Wedington ss. mbr.		
	Batesville ss.			
		Hindsville ls. mbr.		
	Ruddell sh.			
	Moorefield fm.			
	Boone fm.		Stanley sh.	
		St. Joe ls. mbr.	Arkansas novaculite	Upper mbr.
DEVONIAN	Chattanooga sh.			Middle mbr.
	Sylamore ss.			Lower mbr.
	Clifty ls.			
	Penters chert			
SILURIAN	(Missing)		Missouri Mountain sh.	
	Lafferty ls		Blaylock ss.	
	St. Clair ls.			
	Brassfield ls.			
ORDOVICIAN	Cason sh.		Polk Creek sh.	
	Fernvale ls.		Bigfork chert	
	Kimmswick ls.			
	Plattin ls.			
	Joachim dol.			
	St. Peter ss.		Womble sh.	
	Everton fm.	Jasper ls. mbr.		
		Newton ss. mbr.		
		Kings River ss. mbr.		
	Powell dol.			
	Cotter dol.		Blakely ss.	
	Not Exposed		Mazarn sh.	
			Crystal Mountain ss.	
CAMBRIAN			Collier, sh. (Cambrian?)	

SURFACE

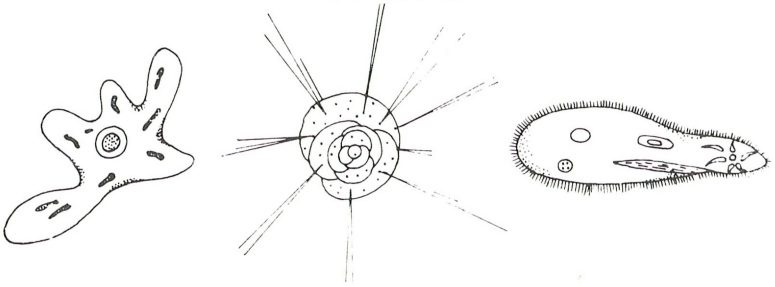
POST-PALEOZOIC ROCKS OF THE GULF COASTAL REGION, ARKANSAS

TERTIARY	Recent	Alluvium and Gravel
	Pleistocene	
	Eocene	Jackson Group
		Claiborne Group
		Wilcox Group
	Paleocene	Midway Group
CRETACEOUS	Upper	Arkadelphia Marl
		Nacatoch Sand
		Saratoga Chalk
		Marlbrook Marl
		Annona Chalk
		Ozan Formation
		Brownstone Marl
		Tokio Formation
		Woodbine Formation
	Lower	Washita Group
		Fredericksburg Group
		Trinity Formation

Figure 15. Charts showing names and ages of rock formations in Arkansas.

PALEONTOLOGY

Protozoa



The phylum Protozoa (pro′-toe-zo′-ah) includes all the one-celled animals, and as might be expected they are, with few exceptions, microscopic in size. Most readers will be familiar with the amoeba, a representative of the protozoans, but the protozoans with which the paleontologist deals are those that secrete or build a skeleton (or "shell") necessary for their preservation as fossils. Two orders are equipped with such skeletons: (1) Radiolaria, which secrete a skeleton of silica, and (2) Foraminifera, which either secrete a chitinous, calcareous, or siliceous skeleton or construct a skeleton from sand grains. Radiolaria, because of their extremely small size, are not likely to be encountered by the amateur paleontologist. Aside from reported occurrences in the Arkansas novaculite, little is known about their distribution in Arkansas. Foraminifera, on the other hand, are common in rocks of different ages in Arkansas, and attention is limited here to this order of protozoans.

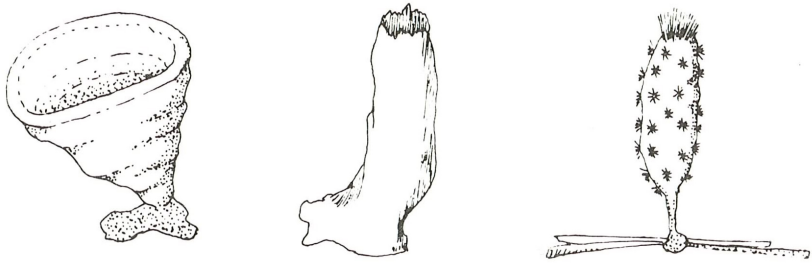
Foraminifera range in age from Ordovician to Recent. The agglutinated forms, or those that build their shells with sand grains, were more common during the early Paleozoic, but by Mississippian time those forms that secrete a calcareous shell became abundant. During the Cretaceous Period calcareous forms experienced a burst in both diversity and abundance, and today their shells constitute an important part of our deep-sea sediments.

The foraminiferal shell consists of one or more chambers that occur in a variety of arrangements. *Paleotextularia*, from the Fayetteville formation (Plate I, Figure 1), has its chambers arranged in "ice-cream-cone" fashion while *Endothyra*, from the Pitkin limestone (Plate I, Figure 4), has chambers arranged in a coil. *Lituola*, an agglutinated form from the Midway group (Plate I, Figure 5), is coiled in early stages but straight in later stages.

All sketches of invertebrates are redrawn from MacGinitie, G. E. and MacGinitie, Nettie, 1949, Natural history of marina animals: McGraw-Hill Book Co., Inc., New York, 437 p. (With permission)

In Arkansas, Cretaceous and Tertiary foraminifers commonly occur in loosely consolidated rocks and they are usually studied as "free" specimens. Paleozoic foraminifers, however, commonly occur in compact limestones, and they are more practically studied in thin-section or with acetate peels.

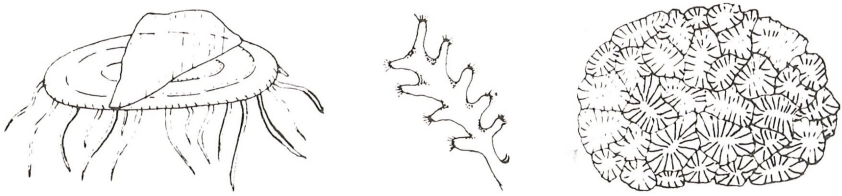
Porifera



Porifera (por-if'-er-ah), or sponges, rarely occur as fossils because many of them lack hard parts. Tiny siliceous spicules (needle-like skeletal elements) are common in some Paleozoic rocks, but entire fossil sponges are rare.

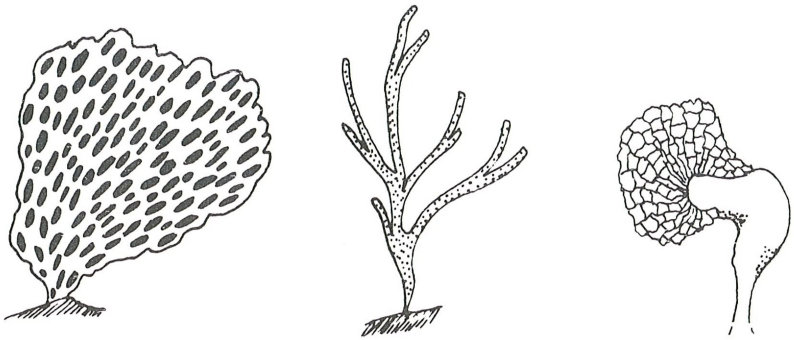
One notable sponge, with a skeleton of calcium carbonate, is *Receptaculites* (Plate II, Figure 1). This genus occurs in the Kimmswick limestone of northern Arkansas.

Coelenterata



Coelenterata (see-len'-ter-ate'-ah) includes the corals, which occur as colonial corals and as solitary corals. In the colonial corals, numerous polyps (individual animals) construct and inhabit a common skeleton, whereas in the solitary corals each polyp constructs his own individual skeleton. In either case, each polyp's "house" (or *corallite*) may be partitioned radially by *septa,* or transversely by *tabulae.* Corals grow attached to the sea floor, and many have been, and continue to be, important reef builders. Floating members of the Coelenterata, such as jellyfish, are extremely rare in the fossil record.

Bryozoa



The Bryozoa (bry'-o-zo'-ah) grow attached to the sea-floor as do corals, but they differ significantly from corals in terms of soft-part anatomy. The bryozoans are exclusively colonial and fall into two broad groups, the lacy colonies, and the twig-shaped colonies. Individual "houses" (*zooeciums*) lack the radial partitions found in corals, but they are divided transversely by partitions called *diaphragms*.

Superficially bryozoans resemble corals, and detailed study is sometimes necessary to distinguish between the two.

A notable bryozoan in Arkansas is *Archimedes* (Plate II, Figure 3). This genus is very common in the Pitkin limestone and consists of a central spiral-shaped axis fringed by a lacy colony.

Brachiopoda



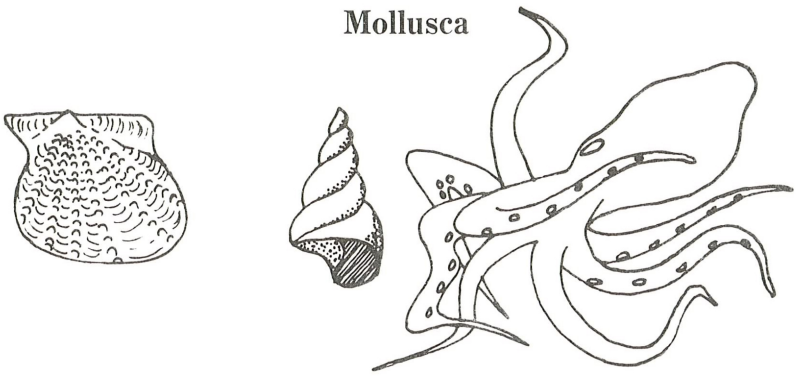
Brachiopoda (brak'-ee-o-pod'-a) is a phylum of marine animals whose soft bodies are enclosed by a shell consisting of two halves (*valves*). In this way they resemble clams, but their soft-part anatomy differs considerably from that of clams. Furthermore, the nature of the valves is quite different from that of clams. The most obvious difference is that the two valves of a brachiopod differ one from the other, but either one can be divided by an imaginary plane into two equal halves. In contrast, the two valves of a clam are mirror images of each other (matched right and left), but either individual valve cannot be divided into two equal halves.

Brachiopods live attached to the sea floor by a flexible stalk. At the *beak* of some species, there can be seen a tiny hole through which the stalk protruded.

Brachiopods have been divided into two broad groups: (1) articulata (those having "teeth" that hinge the valves), and (2) inarticulata (those lacking hinge-teeth). The teeth are hidden from view in specimens in which both valves are together. The great majority of brachiopods are of the articulata variety.

Brachiopods were very abundant during the Paleozoic but gradually gave way to clams. Consequently, brachiopods are common in Paleozoic rocks of Arkansas, whereas clams are common in younger rocks.

Mollusca



The phylum Mollusca includes the familiar classes Gastropoda (snails), Pelecypoda (clams, oysters, and scallops), and Cephalopoda (squids, octopuses, and the chambered *Nautilus*).

Class Gastropoda (gas'-tro-pode'-ah).

As everyone knows snails live on land, but a variety of snails live in lakes and oceans as well. A snail shell is tapered, usually coiled, and "open" throughout; it is not partitioned. Most commonly the coil is in a spire (pig-tail fashion), but some snail shells are rolled up but not spiraled. Snails are common in Paleozoic rocks but are much more abundant in Mesozoic and Cenezoic rocks.

Class Pelecypoda (pee-les'-ee-pode'-ah).

All pelecypods have two valves, but they can be categorized on the basis of shell shapes into clams, oysters, and scallops. Clams, as mentioned previously, have two matched valves, each of which is a mirror image of the other. In oysters the left valve, which is attached to the sea floor, is usually considerably larger than the right. Scallops usually have a slightly larger left valve and crudely resemble brachiopods, but on close inspection individual valves are found to lack the "equal-half" type of symmetry of brachiopod valves.

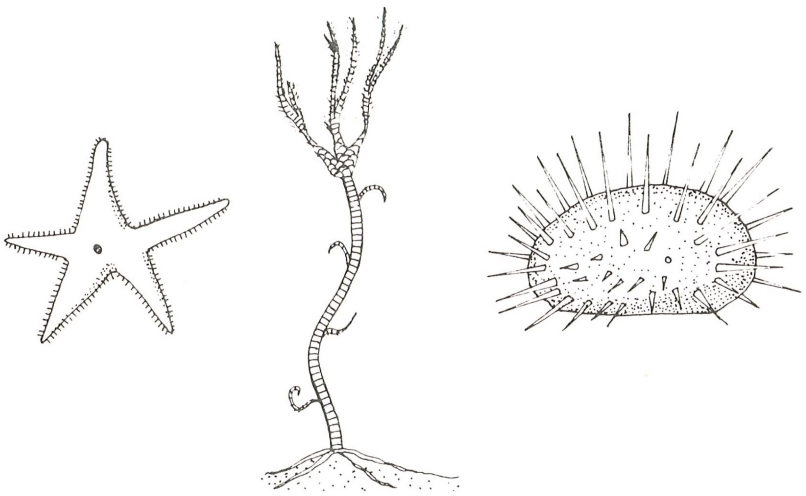
Class Cephalopoda (sef'-a-lo-pod'-ah).

This class is represented in the fossil record by members who built a hard outer shell like that of the modern chambered *Nautilus*. In addition, we also find the record of cephalopods which lacked an outer shell but who, like the modern squid, had a hard internal pin.

The shape of fossil cephalopod shells is highly variable and they cannot be distinguished from snails on shape alone. However, there is one important difference which serves to dishinguish the two. Cephalopod shells are partitioned transversely. These partitions, called *septa*, cannot be seen on the shell's outer surface, but in internal molds of shells the trace of each septum is marked by a line called a *suture*. Each suture is actually a plane that separates the fillings of adjacent chambers.

The character of the septa is a basis for classification of cephapods. Certain Mesozoic forms, called *ammonites*, were characterized by highly complex septa, whereas in another group, the *nautiloids*, simple septa have persisted from Ordovician to Recent.

Echinodermata



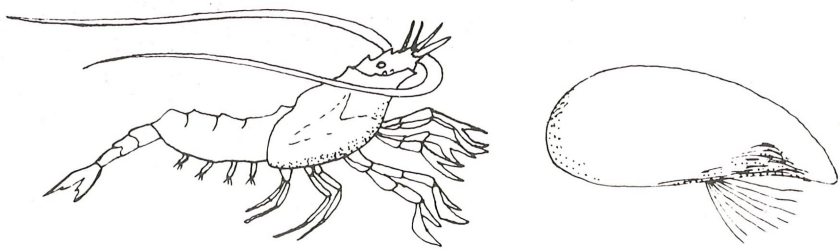
Members of the Echinodermata (ee-kine'-o-der-mata'), which includes starfish and sea urchins, commonly possess pentagonal (star-shaped) symmetry. The phylum can be subdivided into two groups, those members attached to the sea floor and those members capable of crawling about.

The most common echinoderms in the paleozoic were attached types similar to modern-day "sea lilies". Fragments of the stems of these attached forms are by far the most abundant fossils in Paleozoic

rocks of northern Arkansas (Plate VIII, Figure 9). The *calyx*, which housed the soft parts of the animal, is rarely found intact. An exception is the highly symmetrical blastoids which commonly occur in Mississippian and Pennsylvanian rocks in northwest Arkansas (Plate VIII, Figures 3,4).

Those echinoderms capable of moving about, the sea urchins for example, are most common in Cretaceous rocks of southwest Arkansas.

Arthropoda



The phylum Arthropoda (arth'-ro-pode'-ah) includes invertebrate animals with jointed legs. Among the arthropods are all the many species of insects, the lobsters, the shrimp, the barnacles, and many other groups. Two of these groups that commonly occur as fossils are the *trilobites* and the *ostracodes*.

Trilobites

The trilobites (try'-lo-bites) are an extinct group of arthropods that lived during the Paleozoic Era. Each consisted of a head, a mid-section, and a tail, but complete specimens are rare. More common are heads and tails. The mid-section was evidently easily fragmented by waves and currents.

Ostracodes

The ostracodes (os'-tra-cods) range from Ordovician to Recent. They are tiny arthropods that resemble clams, but the shell (*carapace*) encloses a complex body with jointed legs. They live both in fresh and in salt water and are abundant in Arkansas in rocks of all ages.

Their carapaces range from simple oval shapes to highly ornamented forms. The more ornamented forms are more characteristic of younger rocks.

Graptolites

The Graptolites (grap'-toe-lites) are an extinct group of animals that floated about in the early to middle Paleozoic seas. Individual animals lived in tiny cups positioned in rows along slender stems.

The stems of some had a single row of cups, whereas other types had several.

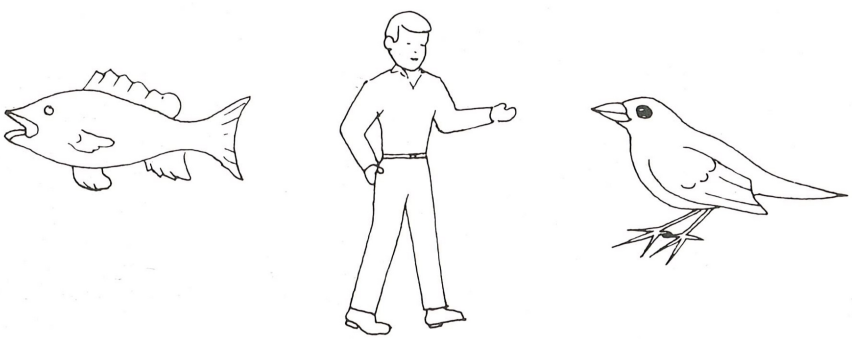
Graptolites appear in shales as flattened films resembling streaks made with a broad graphite pencil. They are abundant at certain places in the Ouachita Mountains, and a favorite collecting site is at Crystal Springs in Garland County.

Conodonts

Conodonts (cone'-o-donts) are tiny tooth-like objects that were parts of a now extinct animal. The exact nature of this animal is still a mystery to the paleontologist, but we know that he enjoyed worldwide distribution in the Paleozoic seas.

Conodonts are calcium phosphate and can therefore be freed from limestone by digesting the limestone in acetic acid. In the Ouachita Mountains conodonts occur mostly as molds in shales of the Arkansas Novaculite and Stanley formation. In the Ozarks they commonly occur in limestones of Ordovician age and younger. A remarkable occurrence of conodonts in the Ozarks is in the Sylamore Sandstone. Usually this sandstone is crumbly, and the conodonts can be easily separated from the rock.

Vertebrates



Compared to invertebrates, vertebrates are rare in the fossil record. Fossil bones are occasionally found in Cretaceous deposits of southwestern Arkansas where several extinct marine reptiles (mosasaurs) have been discovered. Pleistocene deposits (gravels and sinkhole fillings) have yielded mastodon and mammoth teeth and a variety of bones.

By far the most common record of vertebrates is fossil teeth, and shark teeth have been reported from several Paleozoic formations as well as from the Midway group.

Plants

Land plants are fairly common in upper Paleozoic and younger rocks of Arkansas. Some sandstones and shales of both the Ozarks and Ouachitas were evidently deposited on or very close to land as evidenced by fossil leaves and logs.

In addition to land plants, marine algae have left a record in limestones and dolomites of northern Arkansas. Tiny filamentous algae built impressive hummocky structures (called *stromatolites*) on the sea floor. Others encrusted grains and coated them with a thick deposit. These coated grains are called *oncolites.*

Coal deposits of both the Arkansas Valley and Gulf Coastal Plain Provinces reflect lush vegetation that was buried under continental conditions.

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SOURCES OF ILLUSTRATIONS

To obviate needless duplication of effort, many photographs were taken from earlier publications on Arkansas fossils. Plate and Figure numbers referring to such illustrations in this booklet are listed below, preceded by the name of the publication from which they were taken.

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Plate I

FORAMINIFERS

Figure 1. *Paleotextularia*, 45 times natural size. Photograph made from a thin section of the Fayetteville formation, Searcy County.

Figure 2. *Apterrinella*, 45 times natural size, Photograph made from a thin section of the Fayetteville formation, Searcy County.

Figure 3. *Hedraites*, 45 times natural size. Photographs made from a thin section of the Fayetteville formation, Searcy County.

Figure 4. *Endothyra*, 45 times natural size. Photograph made from a thin section of the Pitkin limestone, Washington County.

Figure 5. *Lituola*, 10 times natural size. Midway limestone near Hope.

Figure 6. *Lenticulina*, 45 times natural size. Midway limestone near Hope.

Figure 7. *Globigerina*, 45 times natural size. Midway limestone near Hope.

Figure 8. *Massilina*, 72 times natural size. Midway limestone near Hope.

Figure 9. *Tritaxilina*, 48 times natural size. Midway limestone near Hope.

Figure 10. *Lenticulina*, 21 times natural size. Midway limestone near Hope.

Figure 11. *Nodosaria*, 27 times natural size. Midway limestone near Hope.

Figure 12. *Pelosina*, 48 times natural size. Midway limestone near Hope.



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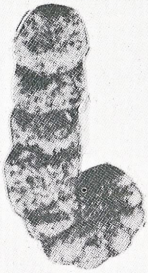

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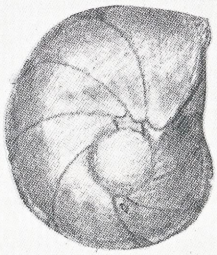

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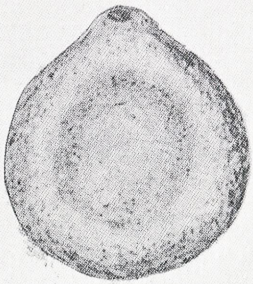

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Plate II

SPONGE AND BRYOZOANS

Figure 1. *Receptaculites*, ⅓ natural size. A sponge that occurs in the Kimmswick limestone of northern Arkansas.

Figure 2. *Rhombopora*, 4 times natural size. A twig-shaped bryozoan colony from the Kessler limestone, Washington County.

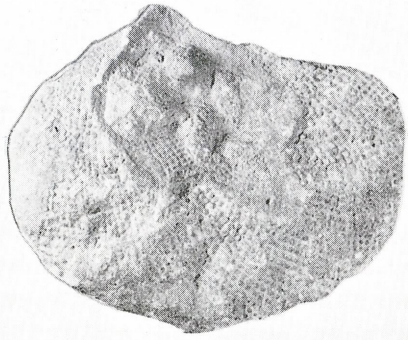
Figure 3. *Archimedes*, natural size. Central spiral-shaped axis with lacy colony preserved in the enclosing rock. Pitkin limestone, Leslie, Searcy County. A *Pentremites* is center left.

Figure 4. *Prismopora*, 4 times natural size. A twig-shaped bryozoan colony from the Kessler limestone, Washington County.

Figure 5. *Septropora*, 10 times natural size. A lacy bryozoan from the Pitkin limestone.

Figure 6. *Fenestella*, twice natural size. A lacy bryozoan from the Pitkin limestone.

Figure 7. *Septopora*, 10 times natural size. A lacy bryozoan from the Pitkin limestone.



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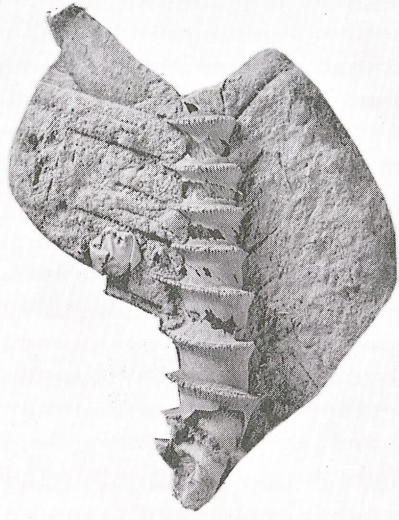

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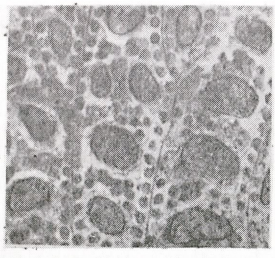

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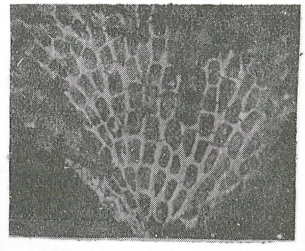

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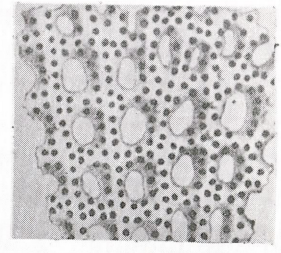

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Plate III

CORALS

Figure 1. *Pleurodictyum*, Natural size. A colonial coral from the Brentwood limestone, Woolsey, Washington County.

Figure 2. *Amplexus*, Natural size. A solitary coral from the Pitkin limestone.

Figure 3. *Amplexus*, Natural size. A solitary coral from the Brentwood limestone.

Figure 4. *Lophophyllum*, 1½ natural size. A solitary coral from the Atoka formation.

Figure 5. *Conularia*, Natural size. A solitary animal with a skeleton suggestive of a solitary coral but assigned to the Coelenterata with question. From the Kimmswick limestone, south of Penters Bluff, Stone Countyq.

Figures 6 and 7. *Zaphrentis*, twice natural size. Transverse section and longitudinal view of a solitary coral from the Brentwood limestone.

Figures 8 and 9. *Pachypora*, Natural size. A longitudinal section and a longitudinal view of a colonial coral from the Brentwood limestone.

Figures 10 and 11. *Triplophyllum*, Natural size. A transverse section and a longitudinal view of a solitary coral from the Pitkin limestone.

Figure 12. *Tetradium*, twice natural size. "Clover leaves" are fillings of corallites of this colonial coral. From the Plattin limestone, Independence County.



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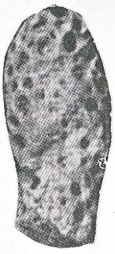

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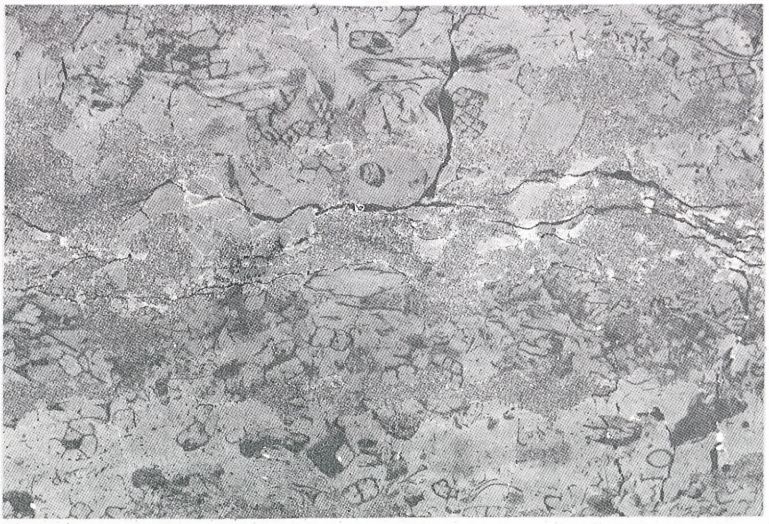

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Plate IV

BRACHIOPODS

Figure 1. *Girtyella*, Natural size. Pitkin limestone.

Figure 2. *Spirifer*, Natural size. Boone formation, Independence County.

Figure 3. *Productus*, Natural size. A silicified specimen from the Fayetteville formation 10 mi. east of Leslie. Spines still intact.

Figure 4. *Triplesia*, Natural size. St. Clair limestone, Independence County.

Figure 5. *Lingula*, 3 times natural size. An inarticulate brachiopod from the Moorefield shale.

Figure 6. *Productus*, Natural size. Fayetteville formation.

Figure 7. *Tetracamera*, twice natural size. Pitkin limestone.

Figure 8. *Orbiculoidea*, Natural size. Pitkin limestone, near Rumley, Searcy County.

Figure 9. *Spirifer*, Natural size. An internal mold from sandstone in the Clifty formation. Near Mundell, Carroll County.

Figure 10. *Composita*, Natural size. Atoka formation.

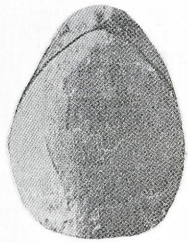
Figure 11. *Leptaena*, Natural size. Boone formation.

Figure 12. *Triplesia*, Natural size. Specimen replaced by manganese oxide. Montgomery Mine, Independence County.

Figure 13. *Rhynchonella*, Natural size. St. Clair limestone, 2 mi. north of Batesville.

Figure 14. *Spirifer*, Natural size. An internal mold from the Boone formation, Independence County.

Figure 15. *Meristina*, Natural size. St. Clair limestone, 2 mi. north of Batesville.



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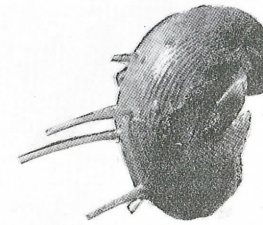

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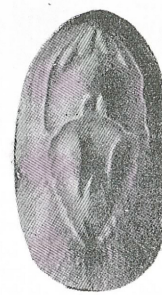

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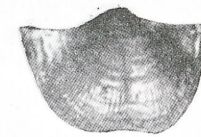

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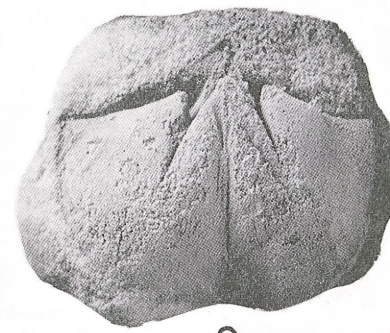

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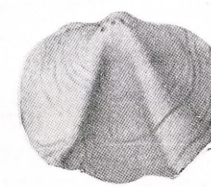

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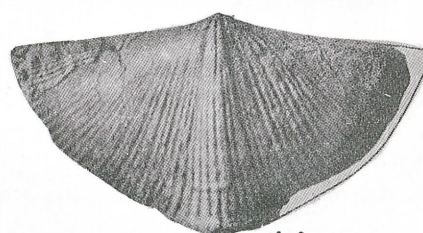

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Plate V

GASTROPODS

Figure 1. *Turritella*, Natural size. Jackson group, Jefferson County.

Figure 2. *Leptoptygma*, 10 times natural size, Pitkin limestone.

Figure 3. *Fusimitra*, Natural size. Jackson group, Jefferson County.

Figure 4. *Straparolus*, Natural size. A non-spirally coiled gastropod from the Hale formation, Fayetteville.

Figure 5. *Schizostoma*, Twice natural size. A non-spirally coiled gastropod from the Atoka formation.

Figures 6 and 8. *Glauconia*, Natural size. Trinity formation, 3 miles northeast of Tokio, Pike County.

Figure 7. *Pseudozygopleura*, 10 times natural size. Pitkin limestone.

Figure 9. *Microptychis*, twice natural size. Pitkin limestone.

Figure 10. *Bellerophon*, Natural size. A non-spirally coiled gastropod from the Pitkin limestone at Leslie, Searcy County.

Figure 11. *Levifusus*, Natural size. Jackson group, Drew County.

Figures 12 and 14. *Glauconia*, Natural size. Trinity formation, Pike County.

Figure 13. *Bucanella*, twice natural size. A very low-spired gastropod. Pitkin limestone.

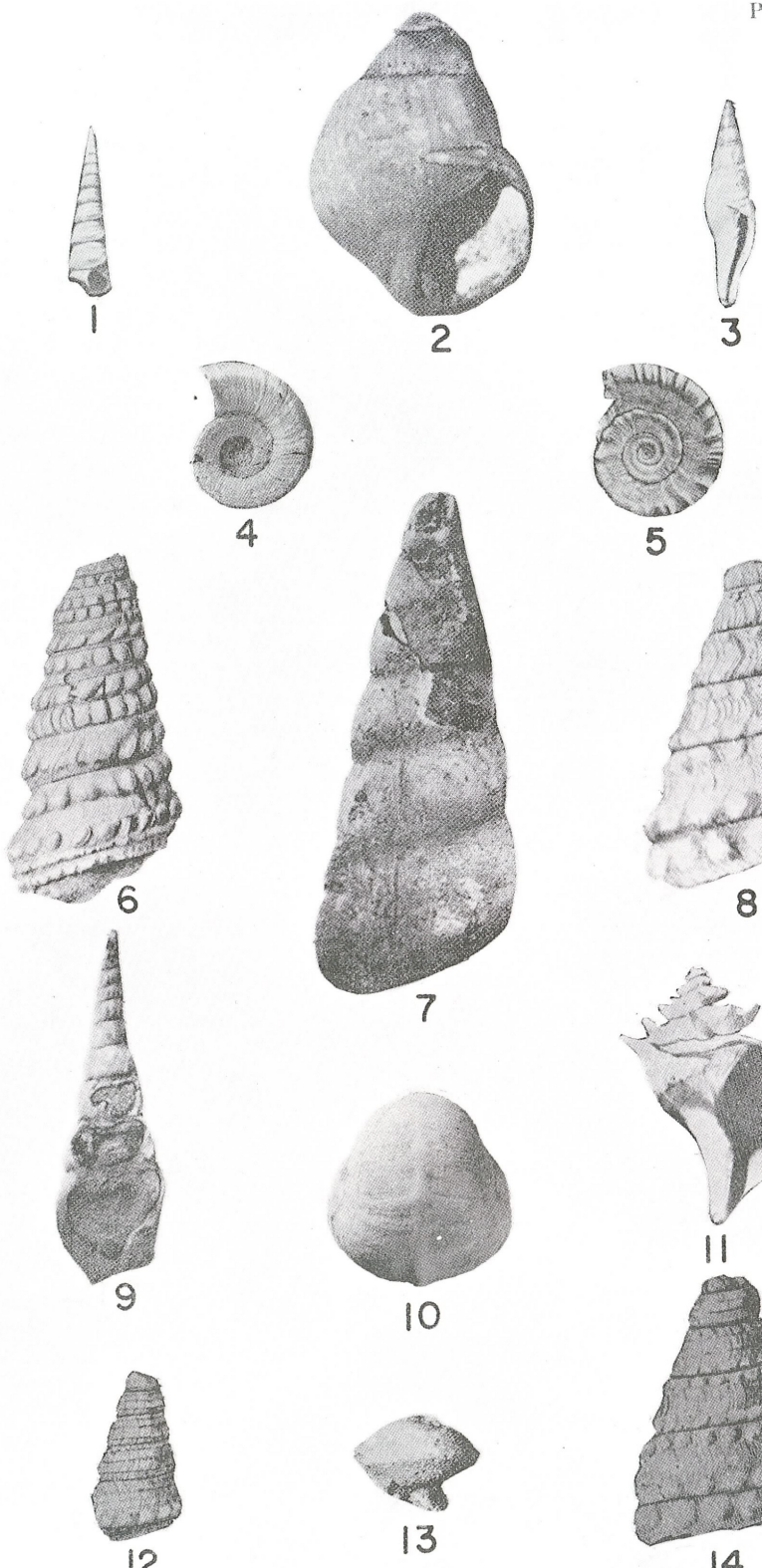
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Plate VI

PELECYPODS

Figure 1. *Ostrea*, Natural size. An oyster from the Trinity formation, 2.5 miles northwest of Delight, Pike County.

Figure 2. *Venericardia*, Natural size. A clam from the Jackson group, Jefferson County.

Figure 3. *Thracia*, Natural size. Tokio formation, Sevier County.

Figure 4. *Eriphyla*, Natural size. Trinity formation, Pike County.

Figure 5. *Exogyra*, Natural size. A large oyster. Brownstown marl, Hempstead County.

Figure 6. *Deltopecten*, Natural size. A large pecten from the Atoka formation.

Figure 7. *Inoceramus*, Natural size. Tokio formation, Sevier County.

Figure 8. *Gryphaea*, Natural size. Ozan formation, 8 mi. west of Arkadelphia, Clark County.

Figure 9. *Nuculana*, 4 times natural size. Jackson group, Jefferson County.

Figure 10. *Myalina*, Natural size. Hale formation, Fayetteville.



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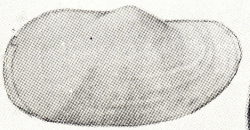

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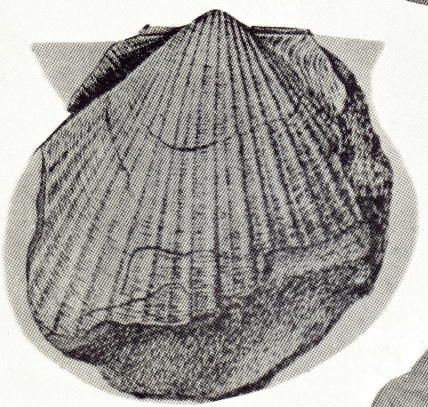

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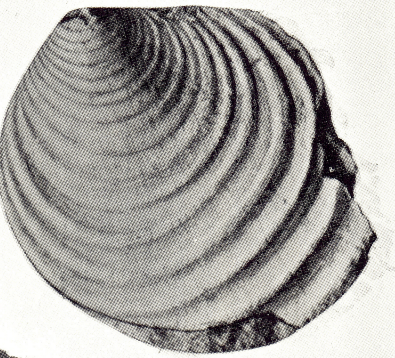

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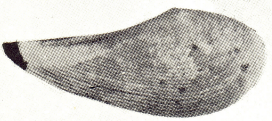

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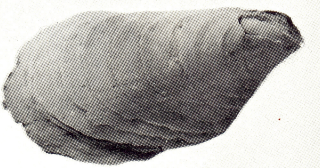

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Plate VII

CEPHALOPODS

Figure 1. *Axinolobus*, Natural size. An internal mold showing sutures of intermediate complexity. Morrow group (?), Greers Ferry, Cleburne County.

Figure 2. *Mortoniceras*, ⅓ natural size. Specimen showing surface features of shell; sutures hidden. Ozan formation, 5 mi. west of Foreman, Little River County.

Figure 3. *Cravenoceras*, Natural size. An internal mold replaced by pyrite. Fayetteville formation, Fayetteville.

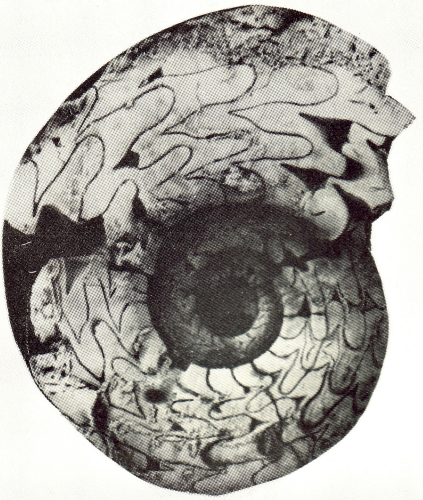
Figure 4. *Gastrioceras*, 4 times natural size. Fayetteville formation.

Figure 5. *Baculites*, Natural size. Internal mold of a nearly straight shell showing very complex sutures. Annona chalk, 0.9 mi. southwest of Yancy, Hempstead County.

Figure 6. *Belemnitella*, Natural size. The internal pin of a Cretaceous cephalopod. Nacatoch sand, Hempstead County.

Figure 7. *Nostoceras*, Natural size. A spirally coiled cephalopod. Shell masks sutures. From Nacatoch sand, 2 mi. northeast of Washington, Hempstead County.

Figure 8. A section of a part of a large straight shell from the Fayetteville formation, Searcy County.



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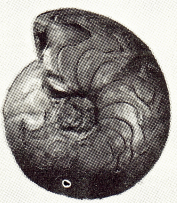

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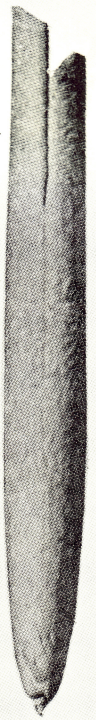

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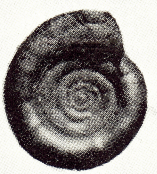

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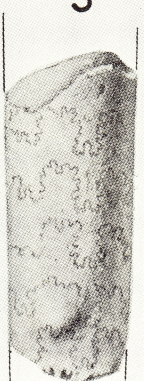

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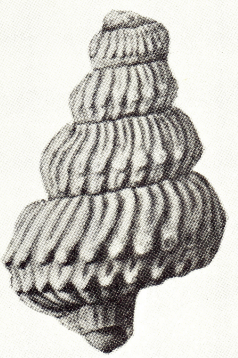

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Plate VIII

ECHINODERMS

Figure 1. *Hemiaster*, Natural size. A sea urchin from the Saratoga chalk, 2 mi. east of Saratoga, Howard County.

Figure 2. *Cosmetocrinus*, twice natural size. A calyx from the Pitkin limestone.

Figures 3 and 4. *Pentremites*, Natural size. Sometimes called "fossil hickory nuts", these housed the soft bodies of blastoids, which are extinct echinoderms. These are common in the Brentwood limestone.

Figure 5. *Linocrinus*, Natural size. A calyx from the Pitkin limestone.

Figure 6. A crinoid stem from the Pitkin limestone at Leslie. Natural size.

Figure 7. *Phanocrinus*, Natural size. A calyx from the Pitkin limestone.

Figure 8. *Phanocrinus*, basal view of calyx.

Figure 9. Crinoid columnals; fragments of a stem. Natural size. From the Boone formation, eastern Carroll County.

Figure 10. *Pentremites*, from the Pitkin limestone. Natural size.



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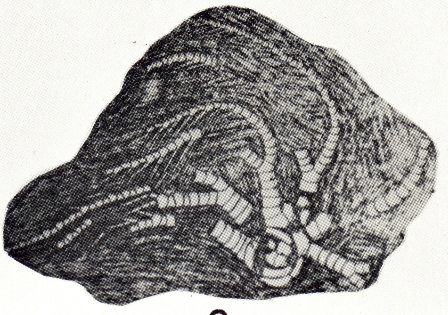

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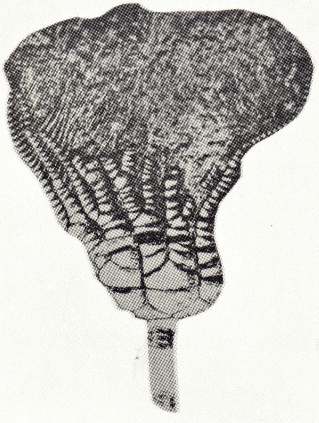

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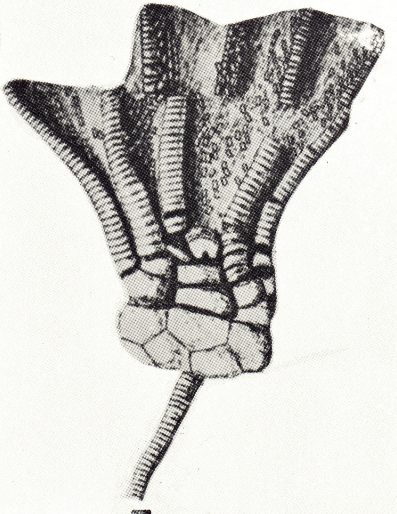

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Plate IX

ARTHROPODS

Figure 1. *Dalmanites*, Natural size. The head region of a trilobite. St. Clair limestone, Independence.

Figure 2. Unidentified trilobite tail. St. Clair limestone.

Figure 3. *Calymene*, natural size. Part of the head region. St. Clair limestone, Independence County.

Figure 4. *Brachymetopus?*, twice natural size. Tail of trilobite, Boone formation.

Figure 5. *Kaskia*, twice normal size. Head of trilobite from Pitkin limestone.

Figure 6. *Bumastus*, Natural size. Tail of trilobite from the St. Clair limestone, Independence County.

Figure 7. *Dalmanites*, Natural size. St. Clair limestone, Independence County.

Figure 7. *Dalmanites*, Natural size. St. Clair limestone, Independence County.

Figure 8. *Paraparchites*, 10 times natural size. An ostracode from the Batesville sandstone.

Figure 9. *Cythereis*, 60 times natural size. An ostracode from the Brownstown marl, southwestern Arkansas.

Figure 10. *Glyptopleura*, 30 times natural size. An ostracode from the Batesville sandstone.

Figure 11. *Cytherura*, 60 times natural size. An ostracode from the Saratoga chalk, southwestern Arkansas.

Figure 12. *Cythereis*, 50 times normal size. An ostracode from the Nacatoch sand, southwestern Arkansas.

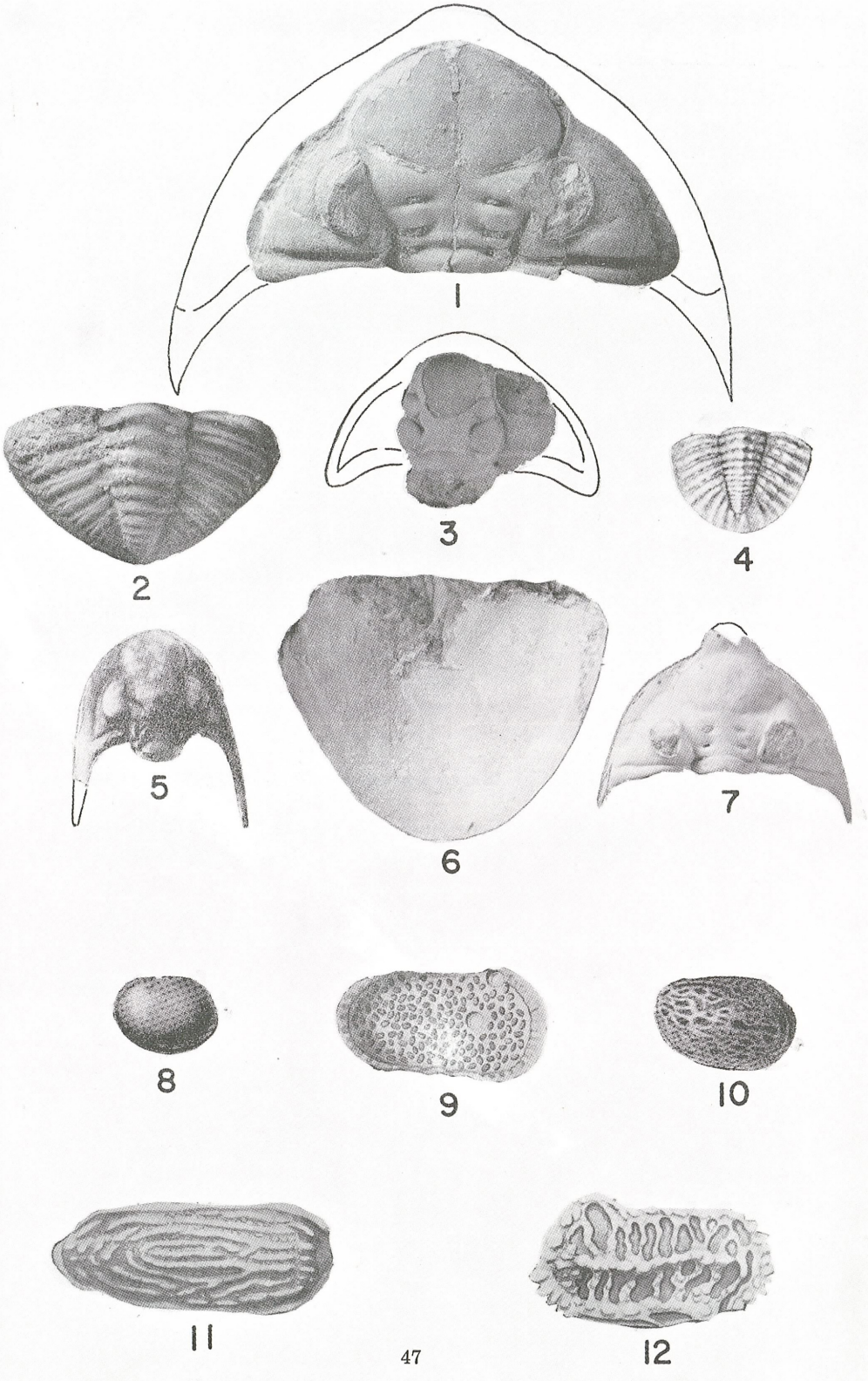
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Plate X

GRAPTOLITES AND CONODONTS

Figure 1. *Nemagraptus*, twice natural size. Womble shale at Crystal Springs.

Figure 2. *Glyptograptus*, twice natural size. Womble shale at Crystal Springs.

Figure 3. *Dicranograptus*, twice natural size. Womble shale at Crystal Springs.

Figure 4. *Retiograptus*, twice natural size. Womble shale at Crystal Springs.

Figure 5. *Diplograptus*, twice natural size. Womble shale at Crystal Springs.

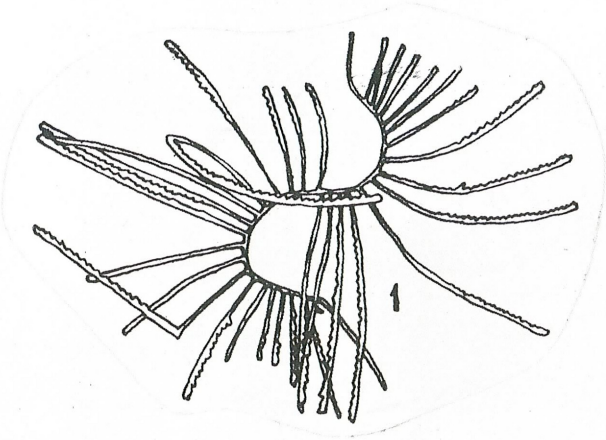
Figure 6. *Climacograptus*, twice natural size. Womble shale at Crystal Springs.

Figure 7. *Elictognathus*, 30 times natural size. Arkansas novaculite at Caddo Gap.

Figure 8. *Polygnathus*, 30 times natural size. Arkansas novaculite at Caddo Gap.

Figure 9. *Gnathodus*, 30 times natural size. Stanley shale at Caddo Gap.

Figure 10. *Palmatolepis*, 30 times natural size. Arkansas novaculite at Caddo Gap.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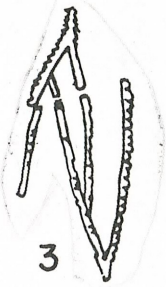
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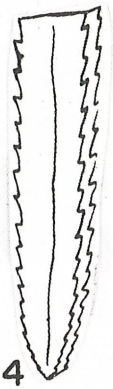
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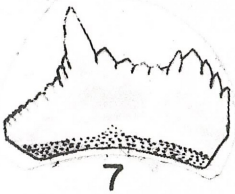
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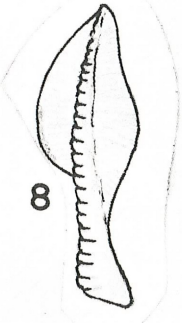
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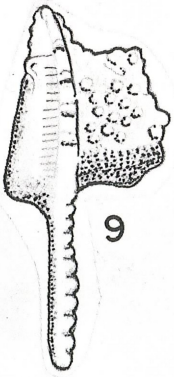
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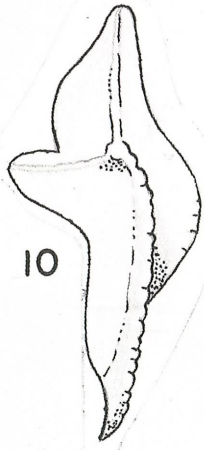
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Plate XI

VERTEBRATES

Figure 1. A sketch of a mammoth tooth (from Mehl, 1962).

Figure 2. A shark tooth from the Midway group in the vicinity of Benton. Natural size.

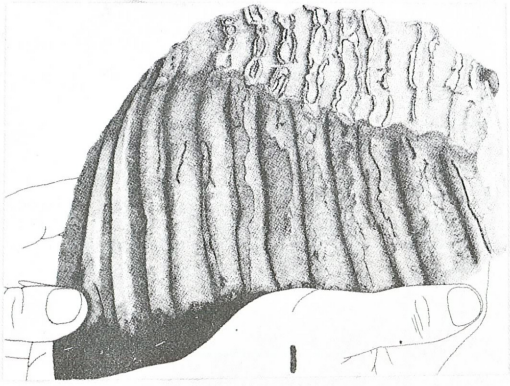
Figure 3. A sketch of a mastodon tooth (from Mehl, 1962).

Figure 4. A shark tooth from the Pitkin limestone. Natural size.

Figure 5. A shark tooth from the Pitkin limestone. Natural size.

Figure 6. A sabre-tooth tiger tooth from the Conard Fissure, Newton County. Natural size.

Figure 7. A cougar tooth from the Conard Fissure, Newton County. Natural size.



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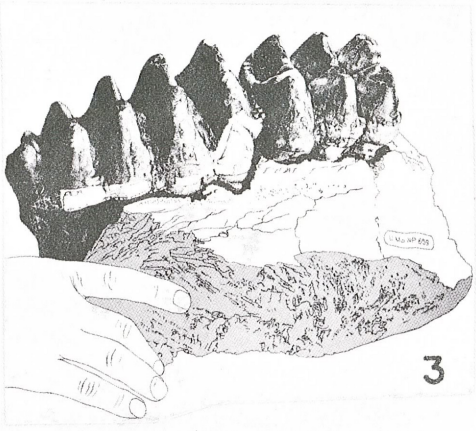

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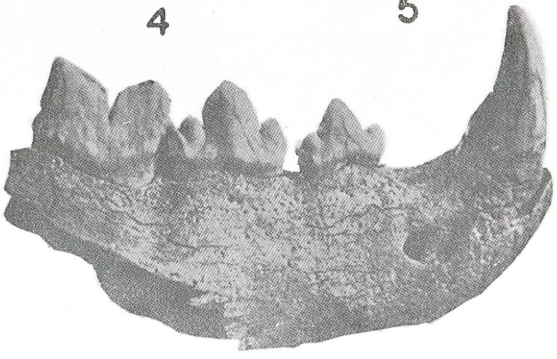

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Plate XII

PLANTS

Figure 1. *Stigmaria*, A giant root found in the Atoka formation each of Chickala.

Figure 2. *Lepidodendron*, A scale tree that occurs in Pennsylvanian sandstones of both the Ozarks and the Arkansas Valley provinces. Natural size.

Figure 3. Stromatolites (algal mounds) in the Joachim limestone northeast of Brandenberg, Izard County.

Figure 4. Oncolites (algal encrustations) in the Pitkin limestone near Woolsey, Washington County. Natural size.



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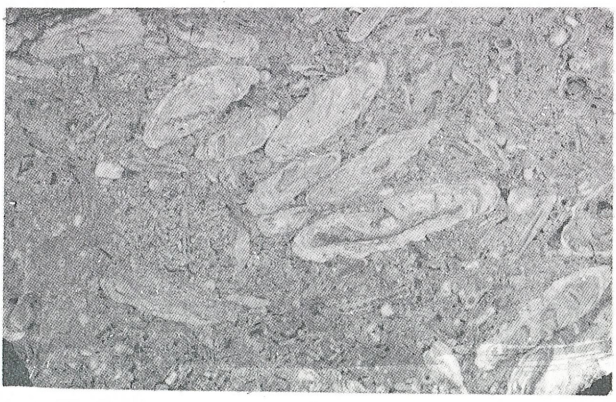

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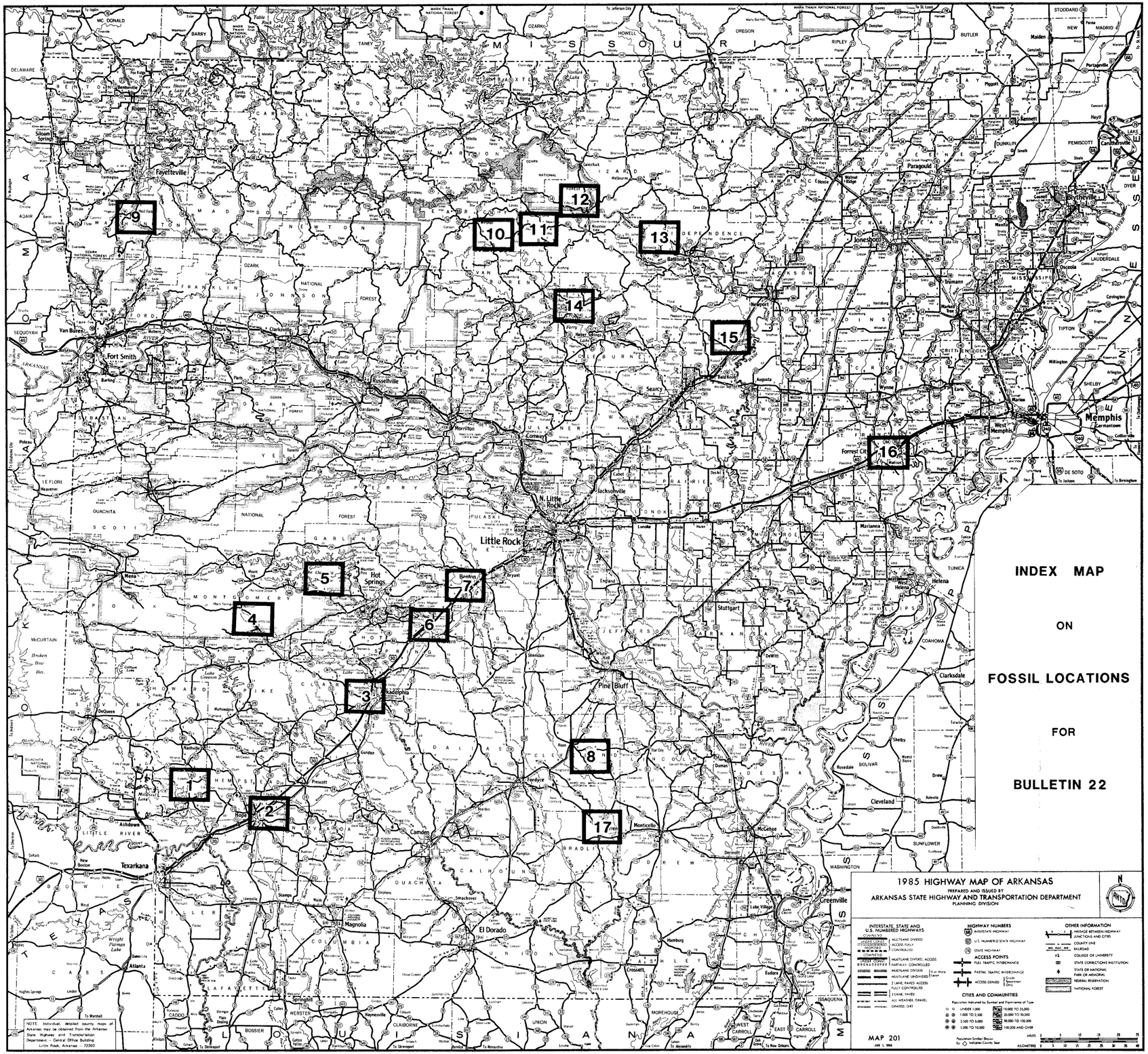
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Jonesboro
Pine Bluff
Texarkana
Memphis
El Dorado
Hot Springs
Camden
Russellville
Batesville
Blytheville
Helena
Clarksdale
Greenville
Monticello
Searcy
Forrest City
Marianna
Van Buren
Harrison
Paragould
Newport
Augusta
Dumas
Cleveland
McGehee
Lake Village
Magnolia
Arkadelphia
Benton
Bryant
Malvern
Stuttgart
Dewitt
Rogers
Siloam Springs
Berryville
Mountain Home
Batesville
Ashdown
Atlanta
Crossett
Hamburg
Eudora
Lonoke
Cabot
Jacksonville
N. Little Rock
Conway
Morrilton
Dardanelle
Ozark
Clarksville
Booneville
Waldron
Mena
Hope
Prescott
Foreyce
Gurdon
DeQueen
Nashville
Lewisville
Texarkana
Stamps
Smackover
Junction City
Strong
Fordyce
Sheridan
Star City
Dumas
Rison
Warren
Monticello
Hamburg
Crossett
Eudora
Lake Village
Greenville
Clarksdale
Cleveland
Shelby
Rosedale
Tunica
Helena
West Helena
Marianna
Forrest City
Wynne
Augusta
Searcy
Newport
Jonesboro
Paragould
Blytheville
Osceola
Piggott
Pocahontas
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Fayetteville
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Berryville
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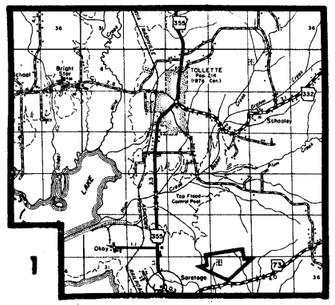

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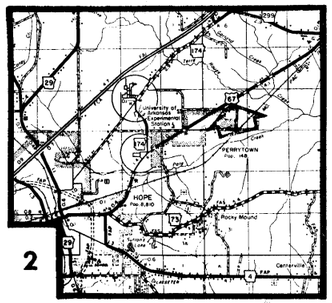
Locality 1 - East of Saratoga along county road 73. Saratoga chalk. Clams, snails, oysters, and echinoids.



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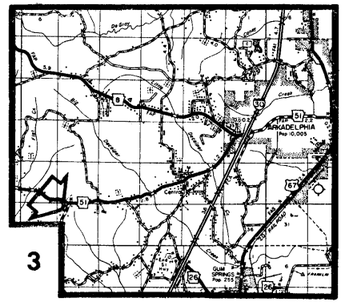
Locality 2 - Northeast of Hope along U. S. Highway 67. Midway group. Shales contain foraminifers and ostracodes.



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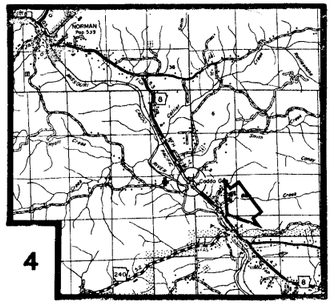
Localigy 3 - Southwest of Arkadelphia along county road 51. Marlbrook marl. Clams, snails, oysters, and vertebrates.



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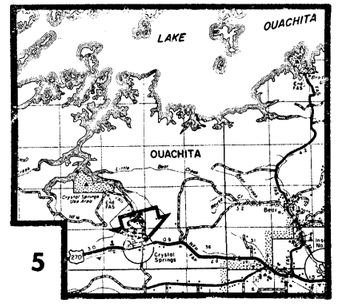
Locality 4 - Southeast of Caddo Gap along county road 8. Arkansas novaculite. Molds of conodonts.



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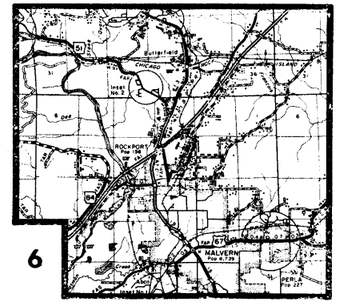
Locality 5 - Northeast of Crystal Springs just off of U. S. highway 270. Womble shale. Graptolites.



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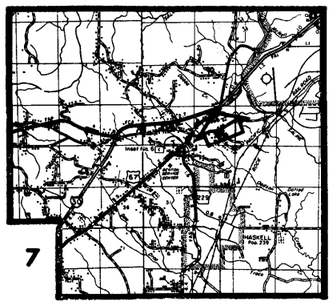
Locality 6 - Where interstate 30 crosses U. S. highway 270. Midway group. Clams, snails, oysters, and shark teeth.



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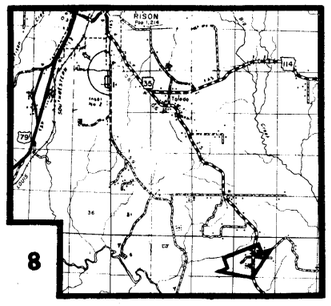
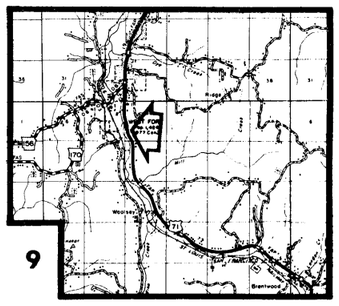
Locality 7 - Southwest of Benton along interstate 30, just west of highway 67 turnoff. Midway group. Clams, snails, oysters, and shark teeth.



8

Locality 8 - Southeast of Rison along county road 35. Jackson group. Tiny molds of clams and snails.



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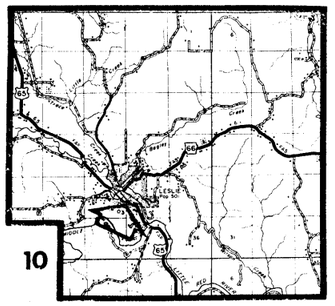
Locality 9 - Abandoned quarry south of Westfork on U. S. highway 71. Pitkin limestone. Brachiopods, bryozoans, solitary corals, oncolites.



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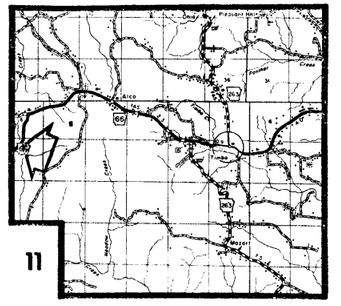
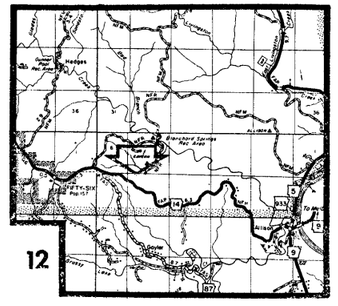
Locality 10 - At Leslie along U. S. highway 65. Pitkin limestone. Snails, brachiopods, large crinoids, bryozoans.



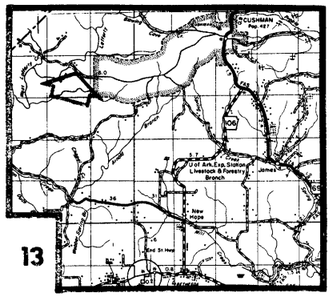
11

Locality 11 - Six tenths of one mile east of Searcy-Stone county line along county road 66. Limestone in the Fayetteville shale. Silicified brachiopods.



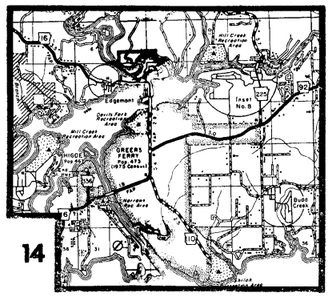
12

Locality 12 - North of county road 14 on road to Blanchard Springs, uphill from cattle guard. Sylamore sandstone. Very abundant conodonts.



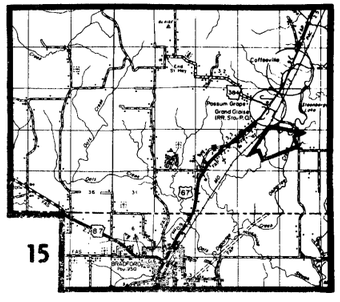
13

Locality 13 - West of Cushman, three tenths of one mile east of East Lafferty Creek bridge. At abandoned side-road is St. Clair limestone. Trilobites, brachiopods, snails, and solitary corals.



14

Locality 14 - Southeast of Edgemont where county road 16 crosses abandoned railroad. Just northeast of road, near bottom of railroad cut, is a bed of limestone of Morrow age. Crinoids, brachiopods, bryozoans, and snails.



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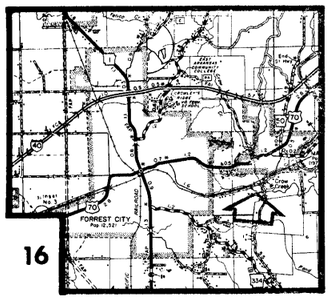
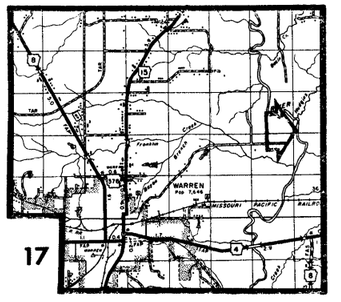
Locality 15 - Along railroad south of Possum Grape. Midway group. Oysters, snails, and echinoids.



16

Locality 16 - Southeast of Forrest City along Little Crow Creek. Jackson group. Oysters, clams, and snails.



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Locality 17 - Northeast of Warren along Saline River. Jackson group. Oysters, clams, and snails.