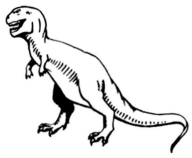
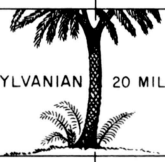
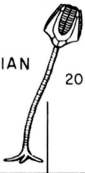
Adventures with Fossils

by
Robert H. Shaver

Circular
No. 6

Indiana Department of Conservation
GEOLOGICAL SURVEY

1959

ERAS	PERIODS	APPROXIMATE LENGTH IN YEARS	ROCK TYPES IN INDIANA	PRINCIPAL MINERAL PRODUCTS
CENOZOIC	QUATERNARY (PLEISTOCENE EPOCH) 	1 MILLION	*Glacial drift: till, gravel, sand, silt (including loess), clay, marl, and peat (Till and gravel contain boulders of many kinds of sedimentary, igneous, and metamorphic rocks)* Thickness 0 – 500 ft.	*Sand and gravel Clay Marl Peat Ground water*
	TERTIARY	60 MILLION	*Cherty gravels, Sand and clay* } *Scattered deposits* 0 – 80 ft.	*Glass sand*
MESOZOIC	CRETACEOUS JURASSIC TRIASSIC	70 MILLION 35 MILLION 30 MILLION	No deposits in Indiana 	
PALEOZOIC	PERMIAN	25 MILLION		
	PENNSYLVANIAN 	20 MILLION	*Shale (including carbonaceous shale), mudstone, sandstone, coal, clay, limestone, and conglomerate* 1,500 ft.	*Coal Ceramic clay, shale Oil and gas Crushed stone Building sandstone Refractory gravel*
	MISSISSIPPIAN 	20 MILLION	Upper Part: *alternating beds of shale, sandstone, and limestone* 500 ft. Middle Part: *limestone, dolomite; beds of chert and gypsum* 300 ft. Lower Part: *shale, mudstone, sandstone; and some limestone* 600 ft.	*Oil and gas Building limestone Crushed stone Gypsum Ceramic shale*
	DEVONIAN 	60 MILLION	Upper Part: *carbonaceous shale* 100 ft. Lower Part: *limestone, dolomite; a few sandstone beds* 40 – 80 ft.	*Oil and gas Crushed stone*
	SILURIAN 	40 MILLION	*Dolomite, limestone, chert, siltstone, and shale* 100 – 300 ft.	*Crushed stone*
	ORDOVICIAN  	70 MILLION	*Shale, limestone, and dolomite* 700 ft. *Limestone, dolomite, and sandstone*	*Crushed stone Oil and gas*
	CAMBRIAN	80 MILLION	*Sandstone and dolomite*	
PRECAMBRIAN ERAS		3 BILLION	*Granite, marble, gneiss, and other igneous and metamorphic rock types*	

Not exposed at the surface in Indiana

GEOLOGIC TIMESCALE AND INDIANA ROCK CHART

STATE OF INDIANA
Harold W. Handley, Governor

DEPARTMENT OF CONSERVATION
E. Kenneth Marlin, Director

GEOLOGICAL SURVEY
Charles F. Deiss, State Geologist
Bloomington

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ADVENTURES WITH FOSSILS

by

Robert H. Shaver

Illustrated by Robert E. Judah

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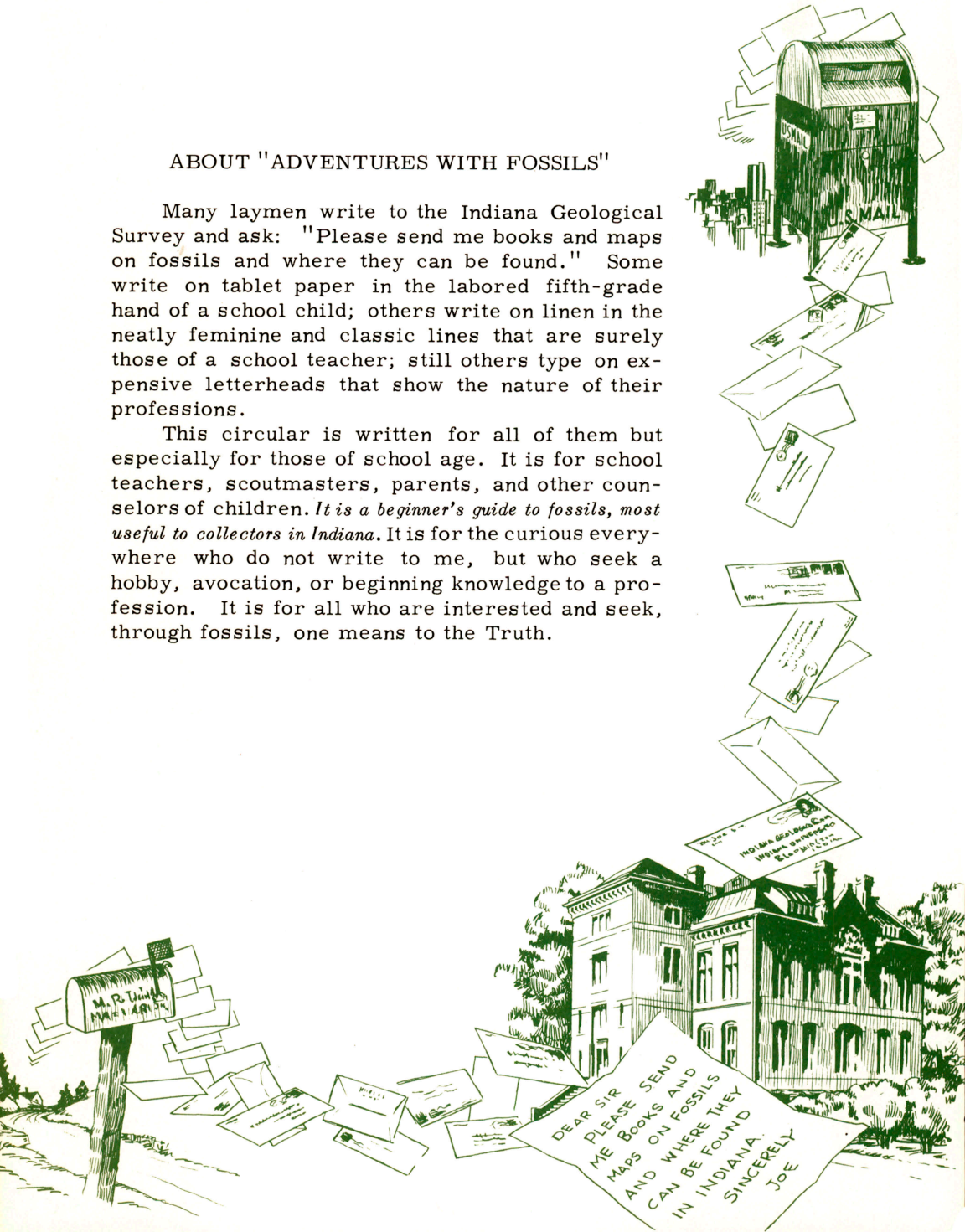
ABOUT "ADVENTURES WITH FOSSILS"

Many laymen write to the Indiana Geological Survey and ask: "Please send me books and maps on fossils and where they can be found." Some write on tablet paper in the labored fifth-grade hand of a school child; others write on linen in the neatly feminine and classic lines that are surely those of a school teacher; still others type on expensive letterheads that show the nature of their professions.

This circular is written for all of them but especially for those of school age. It is for school teachers, scoutmasters, parents, and other counselors of children. *It is a beginner's guide to fossils, most useful to collectors in Indiana.* It is for the curious everywhere who do not write to me, but who seek a hobby, avocation, or beginning knowledge to a profession. It is for all who are interested and seek, through fossils, one means to the Truth.



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HOW FOSSILS ARE MADE

And the rain was upon the earth forty days and nights. And the waters returned from off the earth continually.
–Genesis.

And so it continues today. Rain! Watch it fall in drenching sheets from a sudden summer storm or in a steady drizzle during a dismal November week. It strikes the earth and kicks up little spurts of dust along a street; it spatters on the forest and drips from leaf to leaf and finds its way to earth, drop by drop. Life-giving rainwater soaks into the ground, but some collects in low places to form puddles, pools, and ponds, and these fill up and overflow. Rainwater flows downhill in trickles, rills, rivulets, and sheets, always downhill. Watch rainwater wash a city street clean, and watch it strain itself down the grassy bank of a stream in the meadow.

Moving water has energy; it can do work! A trickle flushes tiny specks of mud down a row of corn and delivers them to a gully which is fed by all the corn rows. The strengthened flow in the gully dislodges a sand grain which bumps and frees another grain, and yet another, to be tumbled forward and downhill. And so it is that the trickles, rills, and sheets flow downhill into larger gullies, brooks, creeks, and finally rivers, all with their loads of mud, silt, sand, and pebbles. Even boulders are pushed before the great river floods, and the rivers dump their sediments and waters into the sea, so that *the waters* (are) *returned from off the earth continually.*

And God said, Let the waters bring forth abundantly the moving creature that hath life,—and (He) created every living creature that moveth, which the waters brought forth abundantly.—Genesis.

Many of these moving creatures (and plants) of the sea are created with bones, shells, and other kinds of hard parts. Upon death, the animal and plant remains, mostly their harder parts, are not greatly different from other sediments which are brought to the sea by rivers. All settle to the bottom and may be shifted to and fro by waves or carried along by currents and spread over the sea floor in layers upon layers. After so many layers pile up and after so much time passes, even millions of years, the sediments are compressed and hardened into *sedimentary rocks*. Some names given to these rocks are *shale, siltstone, sandstone,* and *limestone*. The plant and animal remains which were covered with the sediments and became part of the rocks are called *fossils*.

To be sure, sedimentary rocks and fossils are made in other ways and places--by the wind shifting dust across the plains and sand grains along a beach, by glaciers bulldozing here and dumping there, and by mud and plant debris slowly filling up a swamp or a lake. Indeed, there are yet other kinds of rocks called *igneous* and *metamorphic,* but these are not found in Indiana and rarely contain fossils. They are quite another story not to be told here.

ROCKS, FOSSILS, AND TIME

Sedimentary rocks have been forming since about the beginning of the earth, some billions of years ago! Surely, quite a thickness of layers has been built up by now, especially at places which were covered by seas most of the time. You can understand that the rock layers at the bottom are the oldest, and the layers on top are youngest. Then these layers must represent the passing of geologic time itself! Even the ancient Greeks and Hindus knew this, thousands of years ago.

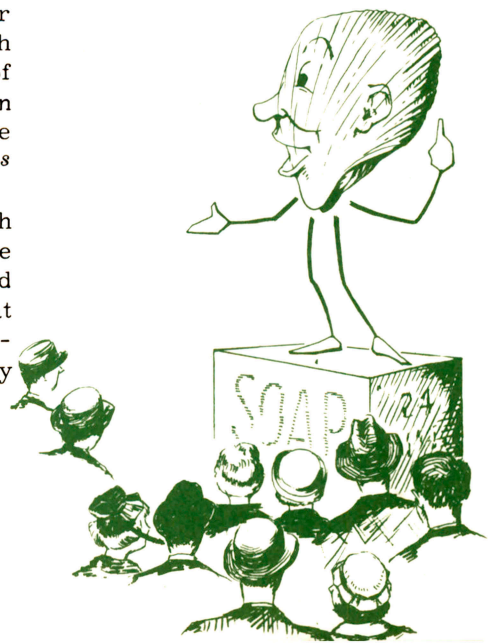
Think of a loose-leaf calendar. A page is turned each day, and near the end of the year the pages are stacked high, one above the other. Each represents an amount of time which has passed. In much the same way the rock layers of the earth record the passing of time. Of course, each rock layer represents far more time than does one page of a calendar. The calendar pages, or days of the year, are grouped into months for convenience. You wouldn't want to say "the 185th day of the year" if you mean July 4th. So is geologic time, and rock layers,

assigned to time units which geologists (people who study the earth) call *eras* and *periods*. Look inside the front cover to see the names of these units and some of the kinds of rocks and fossils which were deposited during each era and period in Indiana. How much easier for us to say "Devonian rocks and fossils" in place of "rocks and fossils that are between 260 million and 320 million years old!" I hope that you use the geologic timescale to see just how your fossils fit into geologic time and the history of life.

WHAT FOSSILS MEAN TO US

You may know that the earth had living creatures and plants long before man arrived to keep a record of these things. Luckily, we know about ancient life because the rock layers and their fossils are a record of that life. Remember to think of the rock layers as calendar pages, and you can understand that the fossils in one layer show some of the kinds of plants and animals that lived when that rock was made. You have learned an important use for fossils. *Fossils tell us about ancient life.*

Much of the bedrock in Indiana is very fossiliferous, so much so that our state offers some of the best fossil collecting in the world. In fact, southeastern Indiana and nearby parts of Ohio and Kentucky have been the cradle of several famous American paleontologists (people who study fossils)--but I'm getting away from the other story. Indeed, many Indiana fossils are marine. That is, they are remains of animals that once lived in the sea. It is hard for us to understand how this can be true, for this dry land of ours, which apparently undergoes little change during our lifetimes, is now so far from the sea shores. But certainly these same marine fossils prove that the enclosing rock was made in the sea. If we know the age of the rocks and fossils, then we also know when seas spread over Indiana. On the other hand, a rock with fossil trees must show that the place of rock formation was land at the time when the trees grew. If you agree, you have learned another use for fossils. *Fossils tell us about the ancient geography of the earth.*



More than 150 years ago, an English engineer named William Smith became interested in the fossils that he found while digging canals. He learned that each rock layer in the banks of his excavations had fossils which are not exactly

the same as the fossils in the layer above or in the layer below. In this way, we first learned that *fossils can be used to identify the different rock layers*. Remember the calendar, and think of the fossils as you do the dates on the pages of the calendar. For example, July 2nd identifies the middle page of the calendar; in the same way, certain fossil sea lilies identify a limestone exposed west of Bloomington, Indiana. The same sea lilies are found in the rock that is exposed at Mammoth Cave, Kentucky, and the two rock exposures are considered, therefore, to belong to the same rock layer. It is important that we can do this, because fossils are used to identify and find certain rocks which contain valuable deposits such as oil, coal, clay, and metals. In fact, *some economic deposits are made mostly of fossils*, as you will learn next.

NEW LOOKS AT OLD FOSSILS

You know now that fossils are connected very much with sedimentary rocks and that they do tell us interesting things about themselves and the rocks. Of course, rocks are everywhere, but many of us never give them a minute's notice. Have you really thought about the rocks and their fossils and just how important they are to us in our everyday lives? I'm going to tell some stories which I hope will show you. At the same time, the stories may show you one way that you can have adventures with fossils.

THE IMMORTALITY OF ENDOTHYRA BAILEYI

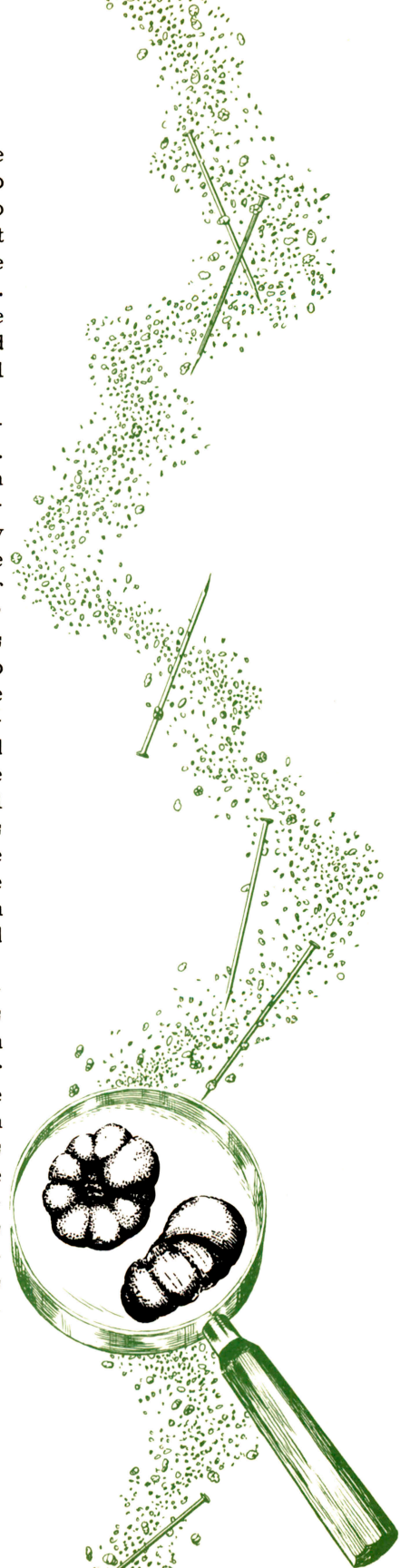
Many millions of years ago, there lived in an ancient sea which spread far over the American Midwest, an amoebalike protozoan whose name was *Endothyra baileyi*. No larger than a pinhead, 6 million of his kind could fit into a top hat! But what an unlikely home, you ask, for one so small. How could *Endothyra* hope to survive in the vast impersonal sea, where wayward currents carried him to hostile waters, where waves wafted him forward to leave him dry upon the strand, where the predatory crustacean and other monsters (to *Endothyra* you may be sure) with hearty appetites ever lay in wait, and where death is more common than life?

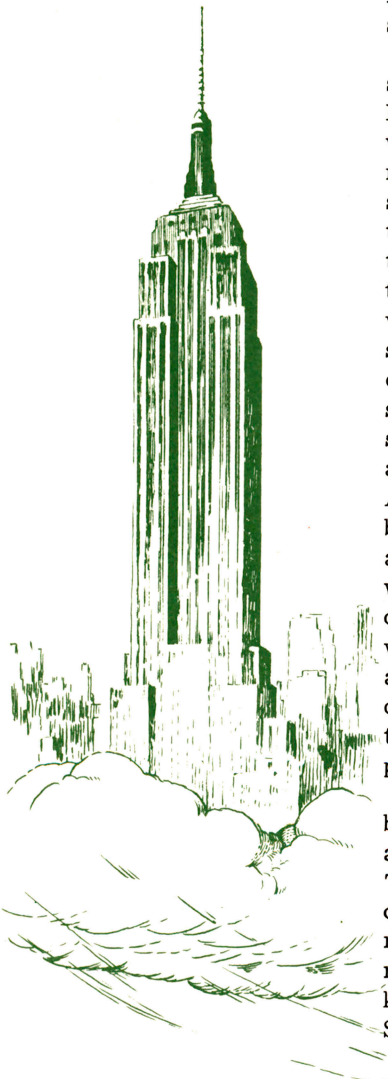
Fortunately, *Endothyra* was no ordinary protozoan, for this presumptious single-celled speck of protoplasm had the wondrous power of secreting a calcareous shell about himself into which he could retreat in order to foil some of his less well-equipped adversaries. The young endothyroid shell had but a single chamber, and, with growth, a new chamber was added from time to time after the

manner of the fabled pearly nautilus. The series of chambers coiled upon itself so that the adult shell had 2 or 3 whorls. No doubt *Endothyra* laughed from his shell at all but the most abrasive forces when he was caught up in the turbulence of the sea. Still, the sea and his enemies must have been hard on *Endothyra*, and he surely needed yet another trick if he was to be successful in the game of life.

Successful he was indeed--at reproduction in unbelievably large numbers. Not restricted by the more modern custom of first finding a mate, *Endothyra*, by division of his protoplasm, created not merely one but scores of new lives at a single reproductive cycle. Looking at it another way, who can say that *Endothyra* ever died? At any rate, if an *Endothyra* failed in his quest for life, there were myriads more to fill the void, and each, when his life cycle had been run, contributed the shell to posterity, perhaps to be dissolved or abraded seemingly to nothingness, and yet to be available for another life cycle, and still another. But wait a moment; many lifeless shells slowly settled to the sea floor to be shifted to and fro and from here to there but at last to be buried by those which followed when each in its turn too had reached the time of passing.

And along with *Endothyra* and his enemies lived many other shelled creatures who led equally perilous lives, and each of whom made life perilous for one or more of his cohabitants according to the order of things upon this earth. So through the centuries and then millennia, the shells of *Endothyra* and his fellow creatures came to rest upon the sea floor and mingled together to build up into banks and layers scores of feet in depth. There were corals, lamp shells, snails, clams, moss animals, sea lilies, sea buds, and crus-



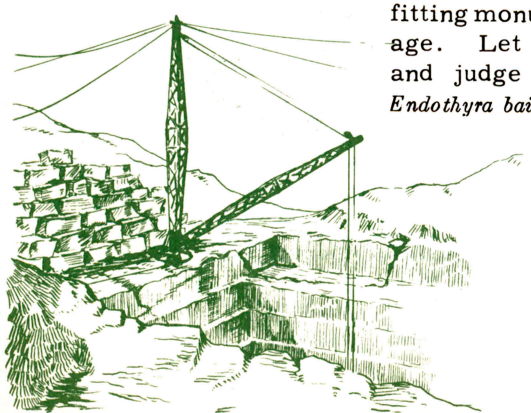


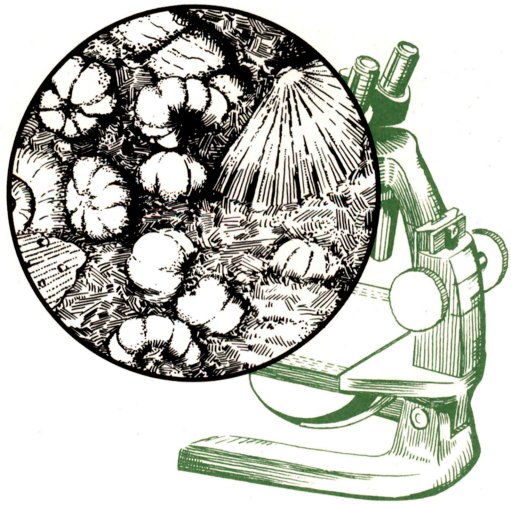
taceans, but in this particular sea *Endothyra baileyi* lived in perhaps greater numbers than any of his shelled contemporaries.

Many millions of years later, when the great sea had washed its last upon the American heartland, and when its life long since had gone its way, a new kind of life came to the Midwest--men, some of whom built houses and cities of stone. They found one kind of stone particularly to their liking, a limestone which crops out upon the surface of the earth in a narrow belt extending in Indiana from the Ohio River northwestward to the west-central border. This stone is uniform, of sufficient thickness, and can be easily cut in any direction. Of pleasing soft colors in gray, buff, and tan, the stone soon was arranged into many houses, churches, and universities in cities and throughout the American countryside. It graced huge public buildings in a great city called Washington. In another great city one orderly pile of this stone was named the Empire State Building. So useful did the stone become that a sizeable industry was founded upon it, and two south-central Indiana counties became the world's largest producing area of building limestone. The value of this stone produced during 1957 by 3,500 employees in Indiana was nearly 20 million dollars.

Let the reader take another look at our building stone--a look through the microscope--and he will confirm what he has already guessed: These two events--the episode of *Endothyra* on the one hand and the founding of an industry many millions of years later on the other--are very much connected. The building stone, better known around the world as Indiana limestone or Salem Limestone, is also the stone of *Endothyra*.

Surely, *Endothyra* found great strength and beauty in numbers and did survive to become fitting monuments to a vast and departed geologic age. Let the reader find what lesson he will and judge as he will on the immortality of *Endothyra baileyi*.





SHADES OF A PENNSYLVANIAN FOREST

A dragonfly spreads full his 30-inch wings and wheels lazily in the sun. His irridescent hues change from red through blues to green as he wheels and turns. He keeps a many-faceted eye on the lookout for lesser insects, or perhaps a spider, which might make a good meal. From time to time, a flurry of wings signifies that he encounters musty updrafts from the green morass below wherever a shaft of sunlight penetrates the dense growth. Supremely confident, he goes his way mindless of time and enemies, for there are no larger insect creatures of the air to harrass him. Indeed, there are no birds.

The sun's rays slant steeply downward and are bent only here and there by the steamy updrafts. The sun shines brightly on the mat of vegetation from which green fingers reach upward to absorb lifegiving warmth. Each leaf silently takes that warmth and, together with carbon dioxide from the air and water through the roots, magically carries on the process of photosynthesis to lock up the sun's energy within itself, and the sun shines on and on.

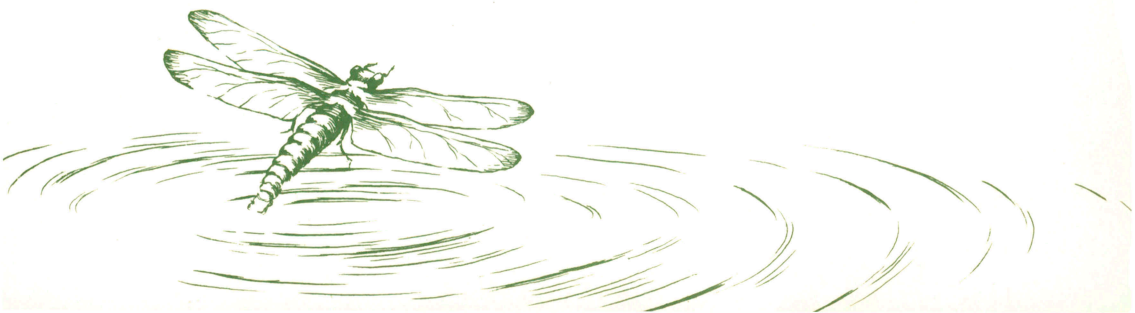
Within the forest, the largest trees have scaly trunks and appear as serpents standing on end and rising straight into the greenish glow of the canopy where forest meets sky. Of lesser size, jointed trees everywhere compete for room and light. And near the musty floor, the struggle goes on in earnest, for primitive ferns, fungi, mosses, and algae carry on in profusion to choke out their weaker

sisters and to be choked out in turn. Each plant in a way contributes to its own death--the algae, best suited for a forest pool, create a floating mat in which rooted plants soon grasp for life; the decaying parts of all convert the pool to peat and soil, so that yet another kind of plant grasps hold. A tree, merely by existing, invites the mosses and parasitic fungi to make a home, so that the whole of the forest floor is a matted crisscross of rotting logs, mostly hidden by the creeping green, with here and there an open pool interspersed with quaking bogs and more solid ground.

Listen! The reader may barely hear, above the flapping of the dragonfly wings and rustle of green, the nearly silent patter of falling leaves, twigs, cones, and seeds, as each falls to earth to be covered by others and grown upon, or sinks into foul red-brown water to putrify. How deep the evergrowing brown and black organic muck in which, except for plants, dare to grow only the anaerobic bacteria that multiply within the slimy mess!

Near the edge of the forest, where the shallow water is yet too deep for plants, a small amphibian rears his head above a floating log and stupidly surveys his world before him. The landscape stretches endlessly to the horizon and beyond, all at the same level, but the shimmering watery waste is endlessly interrupted by the scalloped edges of forested swamps that are numberless. The amphibian, too, is supremely confident, for his world is free of hungry serpents and mammals. He need only share the shallow water with small primitive lungfish and strange armor-plated fishes which might appear to the twentieth century reader as more at home in a Martian sea. He shares the water, too, with the scavenger snail and crustacean, the burrowing clam, and the lowly crawling worm.

And so while the unknowing amphibian waits in the sun on his rotting log for the buzzing insects that venture too close to his silent tongue, a feeding lungfish sets up a circlet of ripples. The rippled arcs spread outward toward the horizon followed only by the unblinking eye of the senseless amphibian. Could this dumb creature but think, would he wonder to what purpose the watery waste before him and the dank forest behind? Would he wonder from what point he is suspended, and if the ripples that spread outward and forever are perhaps his only connecting link in space and time? Does the reader doubt the significance of the ripples and the capacity of the amphibian? Then, let him stare for a while into the depths of the wavering and rippled wetness, where vision is blurred--until the focus is parted and his imagination goes spinning after the spreading ripples through space and time.

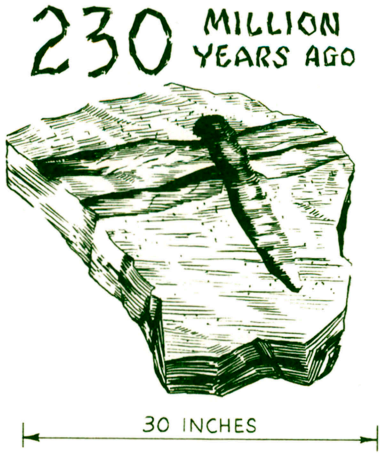


He may see the landscape change through the years as the encroaching sea drowns the forested swamp that is covered soon with sands and limy muds of the sea floor. And as the sea retreats a little, he sees the creeping swamp re-establish itself, and all is repeated, and yet again, until at last both the sea and forested swamp are defeated. For the locale is raised far above the level of the sea, so that river systems grow upon it, and the whole is made suitable for an everchanging parade of life.

The scale and jointed trees, the primitive ferns, and lowly mosses give way to conifers and palms. These in turn are crowded by modern grasses and flowering plants and trees--the oak, maple, sassafras, prairie grass, and cultivated wheat and corn. Meanwhile, the dragonfly and dumb amphibian live long enough to fear the reptilian masses that crawl and fly and that culminate in the dinosaurian horde. The reptiles, too, soon go their way to subjugation by feathered birds, wily mammals, and man.

And also from the watery rippled depths comes smoke, curling along the bent lines of vision. Smoke from factory chimmeys and steel mills, from millions of homes across the countryside, from ships, from steam plants that power civilization, and from the trains that run on shiny rails back to the open pits where giant shovels scrape away the overburden to reveal the black shiny substance called *coal.*

Look closely, Reader, in the coal and enclosing shales, to see the black imprint of a scale tree, the fragmentary tracings of veins



in a dragonfly's wing, scales of a primitive lungfish, and, yes, the unmistakable imprint of an extinct amphibian! Thus it is that the ripples, and indeed the fossils, have completed their mission--and

we are allowed to reflect on our heritage in the shades of a Pennsylvanian forest that flourished 230 million years ago!

HOW YOU CAN FIND FOSSILS

Through the ages, rocks slowly rot or break up (called *weathering)* when exposed to air, rain, and organisms. One product of rock rotting is soil, which then tends to cover up the rock. Compare this with a rotting piece of wood whose outer rotten part covers up the hard fresh wood on the inside. Unfortunately for the fossil collector (but luckily for the farmer and all of us really), much of the fossiliferous bedrock in Indiana has a cover of soil. Most of Indiana is covered also with rock debris, mostly unfossiliferous, that was left by the great glaciers during the Ice Age. We *could* find bedrock anywhere by digging through the soil and glacial deposits. Fortunately, we don't have to do this because there are many rock exposures, made naturally and by man, where we can look for fossils.

KINDS OF ROCK EXPOSURES

Let the reader return to watch rainwater pushing mud and sand down the corn rows and gullies and into the rivers. Watch the soil *erode* slowly to expose the bedrock beneath! Thus, banks of gullies and creeks and river bluffs are good places to look for bedrock and fossils. Some hillsides and cliffs are so steep that rainwash keeps the rock bare of soil.

Man has done his part also. His diggings for quarries, mines, pits, railroad and highway cuts, canals, dams, and foundations present fossil collectors everywhere with nearby exposures of rock where they can look for fossils.

LET'S TAKE A TRIP

Unless you already know a lot about fossils, you may want to go on a collecting trip with an organized group. Whether you are a scout, a

member of a school class, or one of the thousands of adults who make a hobby of "rock hounding," you can have fun collecting fossils in the great out-of-doors while you learn. Speak to your scoutmaster, teacher, or leader; pack a lunch and make a day of it. Scouts can learn about fossils while working for their merit badges; school children can make fascinating displays for a science project or the Science Fair. Church groups and 4-H clubs can put fossil projects on their schedules. All can compete for awards by entering exhibits at conventions that are held by the rock-hound societies. Perhaps most importantly, each one, limited only by the extent of his own curiosity and imagination, can witness scene after scene in the greatest drama of all--the history of life on an ever-changing earth!

Once you decide to take a trip, you will need to make other preparations besides your lunch. A hammer, which has a pick or chisel in place of claws, and a small cold chisel are useful for removing fossils from the rock. You can get these items at hardware stores. A bricklayer's hammer with chisel at one end is cheaper than a regular geologist's pick. A knapsack is handy for carrying fossils. Pencil and paper are needed for labeling. Sacks are useful for keeping the different fossils separated. A small hand lens of 6 to 10 power comes in handy at times.

Leaders of groups generally find it best to visit a site ahead of time in order to learn about access, suitability, and permission. Many good fossil sites are privately owned, and you should get permission before you collect. Most owners, once they understand what you are after, are anxious to help an educational group, but you must respect their rights. If gates are left open, fences damaged, or lunch paper scattered around, they may not let the next group in. Remember that some steep rock cuts are dan-

gerous. Watch for falling and sliding rock in quarries and railroad cuts. Don't climb vertical rock faces; think what might happen if you were perched on a narrow ledge and disturbed a bumble-bee nest! Never go into abandoned mine shafts.

Of course, you may know already of places to collect fossils, or you can look for them, now that you know more about it. But I am going to tell you about some of the best places in Indiana. Probably you can find most of them without maps, but it is best that I state locations of some as completely as possible by what are called *sections*, *townships*, and *ranges*. You may want to learn about these anyway. They refer to the congressional system of land survey which Congress first set up for the Northwest Territory. Sections, townships, and ranges can be seen on county highway maps and quadrangle maps. County maps can be obtained from the county highway department or at the courthouse; quadrangle maps cover a smaller area and cost 30 cents each at the Division of Water Resources, Indiana Department of Conservation, 311 West Washington Street, Indianapolis 9.

INDIANA FOSSIL TRAILS

1. A favorite trail for 100 years.—I have seen many good collecting places all over the United States, but the bluffs at Madison are my favorite. I don't know where else you can find so easily such large numbers and kinds of marine fossils of Ordovician age. Look in the long cuts along Indiana Highway 7 where it goes up the Ohio River bluff just northwest of Madison in Jefferson County (Madison West Quadrangle). The cuts along Indiana Highway 62, opposite the big power plant and west of Madison, are good too. Look for the rock layers with honeycomb-coral masses the size of a basketball! Best of all, I like the safer Pennsylvania Railroad cuts just west of Highway 7. Many famous paleontologists have studied there for more than 100 years. Of course, Clifty Falls State Park at Madison is an excellent place for your picnic. The view across the Ohio is breathtaking, and you can find the same fossils, but leave them in the park for all to see.

2. Quality, not quantity.—The ruins of Tunnel Mill, rare fossils in the tunnel, an old quarry, and nearby Muscatatuck State Park offer a fine day's outing, but don't expect a lot of fossils or to find them without effort. Silurian sea lilies are the prize here, but other good fossils can be found too. A flashlight will help you find them in the walls of the tunnel that extends from the old mill to the Muscatatuck River. Look also in the rocks near the entrance and in the quarry. Take Indiana Highway 3 south of Vernon in Jennings County and stop at a roadcut exactly 0.3 mile south of the junction with Indiana Highway 7. The old quarry is just west of the highway; the old mill and south entrance to the tunnel are 300 yards down hill to the west and along a small stream (Southwest $\frac{1}{4}$ section 11, Township 6 South, Range 8 East, Vernon Quadrangle).

3. Moss animals and then some.—You'll not find better picking of moss animals than in the roadcuts along Indiana Highway 56, 3 miles south of Rising Sun in Ohio County. Yes, thousands are weathered out of Ordovician rocks. Of many kinds, they are branching and simple and smooth and with bumps, and some have star-shaped markings. The cuts are on the right side of the highway where it goes up the Ohio River bluff (SW$\frac{1}{4}$ sec. 16, T. 3 N., R. 1 W., Aberdeen Quadrangle).

4. Nine miles of fossils.—Fifty years ago, Professor Cumings and his Indiana University students spent 2 summers collecting a ton of beautiful fossils from the then new cuts along the 9 miles of the Cleveland, Cincinnati, Chicago, and St. Louis Railroad between Guilford and Weisburg. But I guarantee that he didn't get them all, as many "bugpickers" from the Cincinnati area will agree. A ton of fossils, and much more left after 50 years! No wonder that Indiana offers some of the best collecting in the world. It would be easier to list the Ordovician fossils that are not here; even rare trilobites can be found. Generally, the cuts nearer Weisburg have the most fossils, but if you are a stranger to Dearborn County, you should get the county map or Guilford Quadrangle in order to find the secondary roads that cross the railroad at many points.

Dearborn County fossil hunters with less determination and time can take the easy way out. Some of the same fossils can be picked up easily in the roadcut on the right side of Indiana Highway 48 as it goes up the Ohio River bluff just west of Lawrenceburg (W$\frac{1}{2}$ sec. 15, T. 5 N., R. 1 W., Lawrenceburg Quadrangle).

5. Too easy fossil picking.—But perhaps I can give you enough trouble in finding this old roadcut 3 miles west of Peppertown in western Franklin County, where numerous Ordovician fossils have weathered free of shaly limestones.

If you can find this place, you may not have to lean over. Don't strain your back! Take the secondary road northwest from Peppertown, which is located on Indiana Highway 229. After going 1.7 miles to a series of road junctions, first keep to the left, then right, cross Salt Creek, and then keep left. Turn right after 0.8 mile and stop at the fossiliferous roadcut on the right after 0.2 mile farther ($W\frac{1}{2}$ sec. 17, T. 11 N., R. 12 E., Metamora Quadrangle).

6. Get them while they last.–Indiana doesn't have many places to collect a lot of good Silurian fossils, but one of the best is a quarry on the northwest side of Indiana Highway 46 at the southwest edge of Hartsville in Bartholomew County ($NE\frac{1}{4}$ sec. 2, T. 9 N., R. 7 E.). Look in the gray-blue shale between the two limestones. The shale in the roadcuts on the southeast side of the highway is fossiliferous too.

Good fossils can be collected from the same shale near St. Paul in southeastern Shelby County. Take the secondary road south and southwest from St. Paul along a creek. Keep to the right at the road junction 0.5 mile south of town. A roadcut exposes the fossiliferous shale about 1 mile farther ($NE\frac{1}{4}$ sec. 8, T. 11 N., R. 8 E.).

7. Fossils at Liberty; picnic at Whitewater.–The rocks near Liberty in Union County long have been known as among the most fossiliferous of Ordovician rocks. It's no more than a pleasant bicycle ride from Liberty to a small stream which runs into Silver Creek, where excellent corals, lamp shells, and moss animals can be found. Go 0.5 mile west from the center of town on Indiana Highway 44 and take the secondary road to the left where the highway turns northwest. After crossing Silver Creek, turn north at the intersection and then stop. The small stream east of the road is the place to look ($NW\frac{1}{4}$ sec. 11, T. 11 N., R. 2 W.). Why not have a picnic in Whitewater State Park?

8. You find them.–If you want to collect Ordovician fossils in Richmond, I'm not going to tell you exactly where to look. They're almost everywhere you see a rock exposure near the West Fork of the East Fork of the Whitewater River, northwest part of the city, between U. S. Highways 27 and 35. Even Thistlewaite Falls in the park on the northwest side of Richmond has fossils. If you think the collectors in Richmond didn't leave you enough fossils, I guarantee that 4 miles of rock exposures along Elkhorn Creek, 4 miles south of Richmond, will satisfy you. I speak of that part of the creek between Liberty Pike and Indiana Highway 227. Liberty Pike crosses the creek 5.5 miles south of Richmond; Highway 227 crosses it about 2 miles southeast of South Richmond; the secondary road

straight south of South Richmond crosses the creek 2 miles south of where the road leaves the highway.

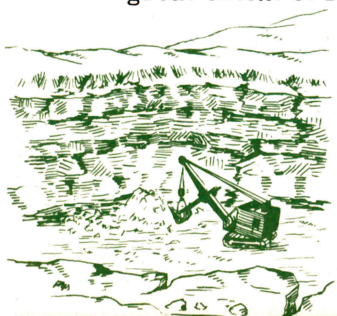
9. Quantity, not quality.—Silurian fossils are abundant in the Erie Stone Co. quarry near Huntington, but they are only in fair shape. The quarry is noted for its many lamp shells and corals, including chain and honeycomb corals. Go 1 mile east on U. S. Highway 24 from the Erie Railroad in Huntington and turn south on North Broadway. After 0.5 mile, turn east on Sabine Street, which leads to the quarry (SE$\frac{1}{4}$ sec. 12, T. 28 N., R. 9 E., Huntington Quadrangle).

10. A fossil reef.—Yes, a quarry near Delphi in Carroll County marks the position of a coralline reef that flourished many millions of years ago in a Silurian sea that spread over Indiana. Many, but only fair, fossils are in the Stuntz-Yeoman Co. quarry west of Delphi, 0.8 mile northwest of the junction of Indiana Highways 25 and 39 and just east of Highway 39.

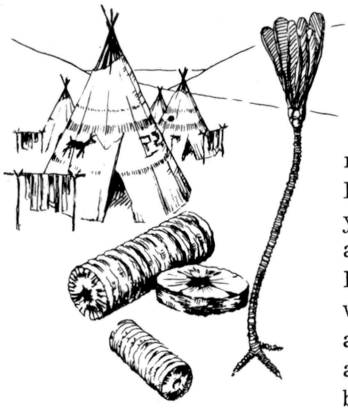
Fossil collectors in northern Indiana are not favored with a great many localities which are good in all respects. However, the Wabash Valley between Delphi and Huntington is indeed unusual because many Silurian fossil reefs are seen in cuts, quarries, and natural exposures. Perhaps you know of good collecting from one or more of the hundreds of reef exposures. Some of the exposures are very fossiliferous, but commonly the fossils are only in fair or poor shape. However, some Silurian fossils are prized for their rarity; for example, trilobites and cephalopods.

11. A bargain stop.—Not often at one place can you collect fossils which date back to two periods of geologic time, but here's a two-in-one bargain. The France Stone Co. quarry near Logansport in Cass County exposes both Silurian (below) and Devonian limestones which contain many corals. The highest (Devonian) layers are at the southeast end of the quarry. See if you can tell that the corals in the lower layers are different from those in the upper layers. Now you can understand better how fossils are used to tell the ages of rocks. The quarry is 2 miles east of Logansport and the Cass County Fair Grounds on the north side of U. S. Highway 25 (NE$\frac{1}{4}$ sec. 27, T. 27 N., R. 2 E., Logansport Quadrangle).

12. Plenty of room.—Fossils are not abundant in most of the rock layers in the spacious abandoned quarry near Spencer in Owen County, but all the more thrill when you find the good specimens. Nor will the other fossil hunters in your group crowd you along the great extent of low shaly limestone benches and boulders that contain good Mississippian lamp shells and corals. Look also for the thin black shale in the islandlike




PENNSYLVANIAN ROCKS
MISSISSIPPIAN ROCKS
SILURIAN AND DEVONIAN ROCKS
ORDOVICIAN ROCKS
MISSISSIPPIAN ROCKS



rock mass near the northwest end of the quarry. Besides larger fossils, it has tiny ostracods which you can retrieve by soaking the shale in water for a few days and treating it as I describe for the Salem Limestone fossils (trails 17 and 18). The quarry was opened by the Midwest Rock Products Corp. and is 1 mile southwest of Spencer and west of Indiana Highway 67 where it goes up the White River bluff (NE$\frac{1}{4}$ sec. 30, T. 10 N., R. 3 W., Spencer Quadrangle).

13. "Indian bead" fossils.—Many years ago, my brothers and I liked to pick mushrooms in a woods near our home. After a time in the woods, we always found it refreshing to drink and wade at a spring which never stopped flowing. We discovered that the sands and gravels which are brought up and cleaned by the spring water contain small discs about a quarter of an inch across. They are knurled on the edge like a dime and pierced in the center in various shapes. We called them "Indian beads" and strung them in necklaces. How surprised we would have been had we known they are the plates of sea-lily stems! And how envious we would have been had we known about the size and abundance of stems in the Stobo lens near Bloomington. The Stobo lens is a reeflike accumulation of limestone, shale, and fossils of Mississippian age and is noted expecially for its stems of sea lilies, some of which are three-quarters of an inch across.

The lens is exposed in the Indiana Highway 46 cut 7 miles east of Bloomington in Monroe County. The highway goes down an escarpment and crosses Stephens Creek 6 miles east of Bloomington; the Stobo lens is 0.3 mile farther and on the north side of the road between two secondary roads to the north (NE$\frac{1}{4}$ sec. 4, T. 8 N., R. 1 E., Unionville Quadrangle). The Stobo lens also is exposed just north of the highway and along the secondary road that is farther east.

14. More "Indian bead" fossils.—An excellent quarry for collecting large Mississippian sea-lily stems and some of the heads is 1.5 miles southwest of New Ross in southeastern Montgomery County. The abandoned quarry is filled with water (careful), but the dump consists of the most abundantly fossiliferous shale and limestone. Take the road that goes south and west of New Ross past the cemetery; turn on the road leading west at the first opportunity and continue west 0.5 mile to where the road turns north. The quarry is west of the road, behind the house which is near the corner and east of Racoon Creek (NE$\frac{1}{4}$ sec. 3, T. 17 N., R. 3 W., New Ross Quadrangle). Remember to ask for permission.

15. A lode of fossils at Silverville.—The abandoned Silverville quarry

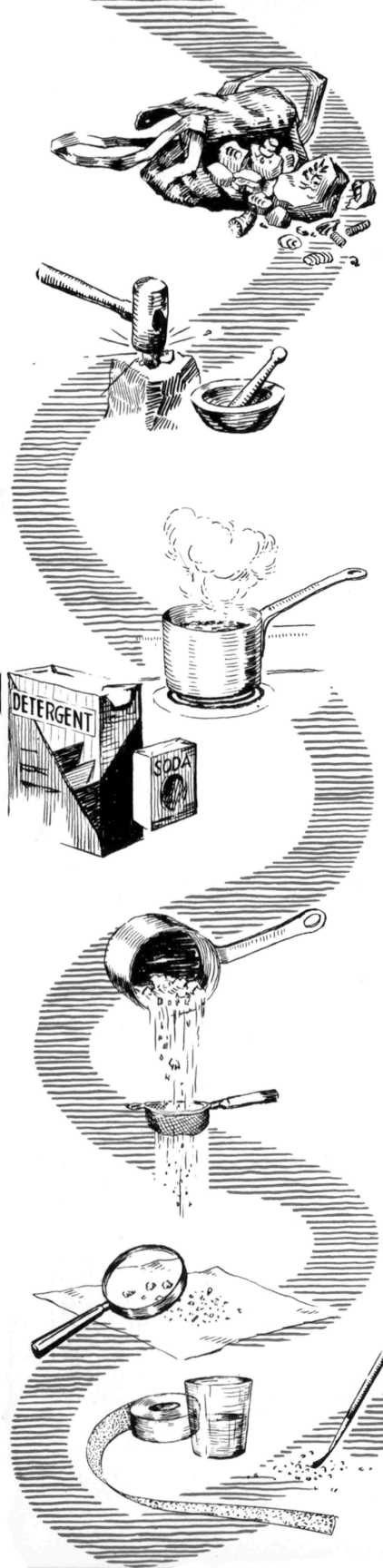
in western Lawrence County long has been a favorite swimming hole. The Mississippian fossils are well worth a few hours of time too. Look in the massive limestone and rubble, and don't overlook the limestone ledges above at the west end of the quarry. The quarry is reached easily immediately north of Indiana Highway 158, 0.8 mile east of Silverville (NE$\frac{1}{4}$ sec. 20, T. 5 N., R. 2 W., Oolitic Quadrangle).

16. For "bugpickers" and rock hounds.—The abandoned Seymour Gravel Co. quarry is fine for Mississippian marine fossils, and rock hounds will be interested in the geodes too. Late summer and fall are the best times to avoid mud on the quarry floor. Take the road that goes straight west from Medora, southwestern Jackson County. The road enters a T-junction 3 miles west of Medora. The quarry is 0.3 mile east of the T-junction and south of the road (SE$\frac{1}{4}$ sec. 29, T. 5 N., R. 3 E., Medora Quadrangle). Look for the old quarry road if you have trouble.

17. Baby fossils.—Here is a unique experience for the fossil hunter and another locality hallowed by paleontologists. The Salem Limestone of Mississippian age is exposed where the Chicago, Indianapolis, and Louisville Railroad cuts through Spergen Hill in Washington County. This limestone is known around the world for its excellence as a building stone, and you can read more about it in the section "New Looks at Old Fossils." Curiously enough, it is made mostly of beautiful dwarf-size marine fossils of many kinds. The snails are noted especially for their variety and beautiful ornamentation. Pick up the coarser, crumbling pieces of rock that have slumped or are scaling off the sides of the cut. The Spergen Hill cut is east of Salem and 2.7 miles west of South Boston along Indiana Highway 160. Turn north on a secondary road where the railroad crosses the highway and go 0.5 mile north to just south of the village of Harristown (S$\frac{1}{2}$ sec. 24, T. 2 N., R. 4 E., Salem Quadrangle).

After returning home, you must take special pains if you wish to appreciate fully these fossils. Crumble or crush the rock and boil it slowly for half an hour in water to which washing soda or a strong detergent has been added. Pour off the water and concentrate the fossils by washing the finer particles through a very fine screen or cheesecloth. After drying, examine the fossils left on the screen with a reading glass or binocular microscope. Further preparation consists of fixing the specimens on cardboard microslides. Use a damp fine-bristled watercolor brush to move the fossils about. If you wet the brush in a solution of gum tragacanth or rub it on sealing tape, the fossils will stick to the cardboard when they dry.

The Salem fossils are named and pictured in a publication by E. R. Cumings and others (Fauna of the Salem Lime-



stone of Indiana, 30th Annual Report, Indiana Department of Geology and Natural Resources, p. 1189-1218, 1906).

18. Fossils that build cities.–Here is another exposure of Salem Limestone and proof indeed that fossils make this famous building stone. Scoop up the crumbled rock debris from the floor and walls of the old Cleveland quarry, and treat it as described for the Spergen Hill material (trail 17). The quarry may be hard to find, so follow instructions closely. The village of Harrodsburg is just west of Indiana Highway 37 in southern Monroe County. Go 1 mile north of the center of town on the secondary road and stop. The quarry is a few hundred yards west of the road and can be spotted in the woods by the pile of huge limestone blocks ($NW\frac{1}{4}$ sec. 20, T. 7 N., R. 1 W., Clear Creek Quadrangle). You may have noted the active quarries along Highway 37 when you came. The Salem Limestone is quarried from them and shipped all over the United States.

19. Historical fossils.–The Falls of the Ohio are renowned in early American history, and now the Louisville metropolitan area is here. The Falls are also long-famous to paleontologists for many Devonian corals and other fossils which can be seen best during the fall of the year when water is low in the Ohio River. Look in the exposed river bed and bank. The exact location is at the southwest edge of Jeffersonville, Clark County, along Riverside Drive at the Pennsylvania Railroad bridge, and downstream near Dam No. 41 (New Albany Quadrangle).

20. Don't go near the water.–If the water is high at the Falls of the Ohio, fossil collectors in the Louisville area can turn to western Clark County. A small exposure of green shale of Mississippian age 1 mile north of Carwood is filled with small corals, lamp shells, sea-lily stems, moss animals, cephalopods, and others. Pick them up

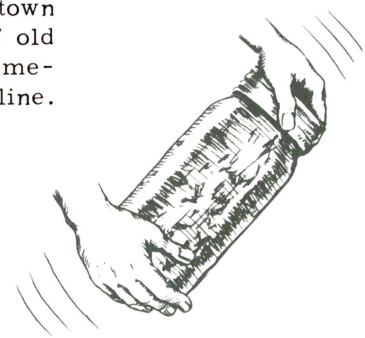
where they have weathered free of the shale, or take a bucketful of the most fossiliferous shale home. Put some of the shale in a large fruit jar of water and shake it up; pour off the muddy water and repeat. Soon the fossils will be concentrated enough in the jar for picking. You can also boil the mud for better concentration of the fossils. Carwood is just north of Indiana Highway 60. Go north of town on the secondary road and pass two road intersections. The exposure is in the roadcut 1 mile north of town and just south of a small stream crossing (center of the west line, sec. 4, T. 1 S., R. 6 E., Speed Quadrangle).

21. For better Mississippian fossils.–The abandoned Lutgring and Sons quarry in northern Perry County is one of the best places in Indiana for marine fossils of Mississippian age. Even prized sea lilies have been found there. Chip the fossils out of the shaly limestone, some of which lies in blocks on the quarry floor. Some of the black shale in the quarry face above the massive limestone is loaded with tiny fossils, but collect only where you can see the fossils. The shale and its fossils can be washed as I have described for Spergen Hill (trail 17); it might help to first soak the shale in water for a day or two. The quarry is near Branchville, 2 miles east of Indiana Highway 37. Go 0.6 mile on the road east of the village; the quarry can be seen 0.1 mile north of the road (SE$\frac{1}{4}$ sec. 18, T. 4 S., R. 1 W., Branchville Quadrangle).

22. Fine quality Pennsylvanian fossils.–The open abandoned coal pits near the village of Buffaloville in northern Spencer County offer fine collecting of Pennsylvanian fossils. A good place is 0.25 mile north and 0.6 mile west of the village, where pits are found on either side of the road (NW$\frac{1}{4}$ sec. 9, T. 5 S., R. 5 W., St. Meinrad Quadrangle). Look in the dumps on the west side of the pits for good lamp shells; the rubbly limestone and shale which stick out of the bank near the bottom of the pit have many tiny fossils, especially ostracods. You should see Lincoln State Park while you are so close.

23. Take your choice.–Do you like plant fossils or marine shells? Warrick County has them. Don't pass up the many plant fossils waiting on the dumps of an abandoned Quality Coal Co. mine. Go 3 miles north of the center of Boonville on Indiana Highway 61 and turn west on the secondary road. You can see the dumps north of the road and 0.2 mile west of the highway (SE$\frac{1}{4}$ sec. 9, T. 5 S., R. 8 W., Boonville Quadrangle). How about a joint trip, fossils at the coal mines and a picnic in Scales Lake State Park?

If your taste runs more to marine fossils, get out your roadmap and draw a line between Scalesville and Yankeetown and through Boonville. You'll find plenty of old coal-mine pits which expose fossiliferous limestones and shales within a mile or two of this line.



Some of the fossils have been turned into pyrite (fool's gold). One good place is a pit of the Sunlight Coal Corp. which is exactly 2 miles north of the center of Boonville and 0.2 mile west of Indiana Highway 61 (SW$\frac{1}{4}$ sec. 14, T. 5 S., R. 8 W., Boonville Quadrangle).

24. The bluff at West Franklin.–The Evansville area offers fair collecting. Try the Pennsylvanian limestone ledges in the Ohio River bluff which begin along the dead-end road just east of West Franklin near the southeast corner of Posey County (S$\frac{1}{2}$ sec. 24, T. 7 S., R. 12 W., Henderson Quadrangle). You have to walk to the best exposures, which are beyond the cabins and dead-end road. The patient collector can find many lamp shells and snails. Look also for the thin black shale 1$\frac{1}{2}$ feet below the top of the lower limestone ledge. It has corals and many microfossils. You may have noted the yellow silt exposed in the roadcut through the bluff above West Franklin. Look carefully for tiny snails in the silt. Take some silt home and treat it as I described for the Carwood fossils (trail 20).

The limestone layers seen at West Franklin are exposed also near Evansville and elsewhere in Vanderburgh County. Look in the ledges on the east side of U. S. Highway 460, near Mesker Park Zoo, on the northwest side of the city; many lamp shells are just lying around in an abandoned limestone quarry 1.5 miles east of Stacer and U. S. Highway 41 and south of the county road (SW$\frac{1}{4}$ sec. 22, T. 4 S., R. 10 W.).

25. Eleven miles; 230 million years.–Fossil collectors from Vincennes have only to travel 11 miles to be taken back 230 million years to a coal swamp. Carbonaceous plant fossils abound in the dump of the White Ash mine near Wheatland. Split the shale open to find the best imprints. Some petrified wood is there too. The dump is just west of the mine buildings and north of U. S. Highway 150 and the Baltimore & Ohio Railroad 2 miles west of Wheatland, Knox County (N$\frac{1}{4}$ Donation 81, Wheatland Quadrangle).

26. Fossils you can crack.–Yes, you first find the rounded gray or tan nodules that are the size of a walnut to a fist; turn them on edge and crack them open with your hammer. It's like opening surprise packages. Some are disappointments, but others have beautiful imprints of ferns and other plants on the inside in which the fine details can be seen. Look for the nodules in the shale cuts and dumps of the Maumee Chieftain mine south of Terre Haute, Vigo County. In fact, some of the shale itself has plant fossils. Go 1 mile south of the village of Youngstown on U. S. Highway 41; turn east on the secondary road and go exactly 2 miles; turn south on the haulage road and take the right fork after 0.4 mile; look for the fossils after 0.5 mile and beyond (Lewis Quadrangle). If the mine is

active, you should ask for permission.

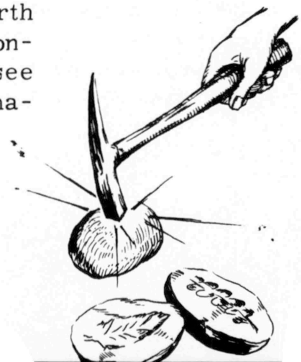
While you are so near, it would be a shame to leave so many lamp shells, sea-lily fragments, and other fossils in the several abandoned strip mines on either side of Indiana Highway 159 north of Blackhawk and south of Riley. The mines are too numerous to list, but those which expose a limestone are the places to look.

Now skip down to Pike County for more fossils-to-crack. Go 2.8 miles southwest of Petersburg on Indiana Highway 57 to where the road curves sharply right and where an old strip mine is just to the right of the highway. The nodules are most abundant in the northwest part of the stripped area ($N\frac{1}{2}$ sec. 9, T. 1 S., R. 8 W.).

27. Don't keep them waiting.–Pennsylvanian lamp shells, stems of sea lilies, snails, and clams await the collector in the limestone and black shale above the mined-out coal at the old Min Win mine near Petersburg in Pike County. Petrified plant remains can be found in some of the "coal balls" on the mine dump. Go 2.5 miles northeast of Petersburg on Indiana Highway 57 to Lick Creek School and Church at a road junction. The mine is a few hundred yards west of the highway at this point. An old mine road leaves the highway 0.2 mile south of the school ($SE\frac{1}{4}$ sec. 13, T. 1 N., R. 8 W., Sandy Hook Quadrangle).

Similar fossils can be found in many nearby dumps of strip mines too numerous to list. Look for the dumps north of Indiana Highway 257 2 miles southwest of Pikeville (secs. 26 and 35, T. 2 S., R. 7 W.); others are 2 miles east of Augusta along secondary roads (secs. 14 and 23, T. 2 S., R. 7 W.); still others are within 3 miles of Spurgeon to the east, northeast, north, and northwest (T. 3 S., R. 7 W. and R. 8 W.). Look 1 mile north of Winslow (secs. 29 and 32, T. 1 S., R. 7 W.) and 3 miles northwest of Winslow along the Hosmer road (secs. 25 and 26, T. 1 S., R. 8 W.); others are at Cato both north and south of Indiana Highway 56 (secs. 10, 16, 17, and 20, T. 1 S., R. 7 W.).

28. Fossils worth their weight in gold.– Ah yes, but fool's gold, for at this abandoned strip mine near Jasonville in Greene County, some of the fossils have been turned into pyrite, which just looks like gold. But they should be worth enough for you to follow these directions very closely. Go exactly 1.5 miles south of Indiana Highway 48 on the road that is $1\frac{1}{2}$ blocks west of the Chicago, Milwaukee, St. Paul, and Pacific Railroad in Jasonville. Turn west at the intersection, cross the railroad spur, go past the first strip pits you see, and stop 0.4 mile west of the railroad spur. You may find an old lane leading to the pit that is 0.3 mile north of the road ($SE\frac{1}{4}$ sec. 8, T. 8 N., R. 7 W., Jasonville Quadrangle). If you're not lost, you'll see that the pit exposes two shaly limestones with ma-



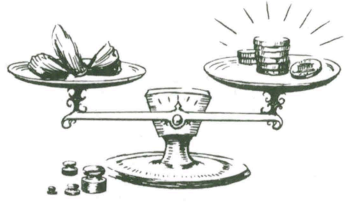
rine Pennsylvanian fossils. The lower limestone is 1 foot thick but is not present everywhere; it has petrified wood as well as fossils of fool's gold.

Actually, you can collect snails, lamp shells, clams, and sea-lily fragments, some in fool's gold, from the same limestones in many abandoned strip mines near Jasonville. If you continue west for 1.5 miles on the road mentioned above and then go south for 0.8 mile, you'll be in Gilmour. The old mines both north and south of Gilmour and on either side of the road are good places to look for fossils (secs. 13, 18, 19, and 24). Other good mines are less than 1 mile north of Coalmont and west of Indiana Highway 159 (secs. 19 and 30); still others can be reached if you go 0.5 mile west of Coalmont and turn north on the county-line road. Several mines can be seen west of the road for the next 2 miles (secs. 13, 24, and 25.). Only the lower of the two limestones, where present, has the fossils made of pyrite, but of course the upper limestone has good fossils too.

29. County-line fossils.—Owen and Clay Counties share the Pennsylvanian fossil beds which are unearthed in old coal pits along their county line. The Commodore mine is best. Look in the limestone, and shale below, for corals, lamp shells, and microfossils. From Coal City go 0.25 mile north, turn and go west 0.5 mile, turn north, and stop after 0.7 mile. The Commodore mine is identified by its small lake and is just southeast of the dumps and 100 yards east of the road (SE$\frac{1}{4}$ sec. 2, T. 9 N., R. 6 W., Coal City Quadrangle).

30. Fossil poaching.—Many good marine fossils of Pennsylvanian age await Hoosiers just 4 miles beyond the Illinois state line in the Terre Haute area. An abandoned quarry of easy access and with a pleasant waterfall is immediately north of St. Aloysius Church, 5 miles northeast of Paris, Illinois. Continue north 2.5 miles on U. S. Highway 150 from the dam on Twin Lakes just north of Paris; turn east; after 2 miles, jog south 0.2 mile; go east again for 2 miles to arrive at St. Aloysius Church (NE$\frac{1}{4}$ sec. 10, T. 14 N., R. 11 W., Paris Quadrangle).

31. Fossils large and small.—This exposure of fossiliferous Pennsylvanian limestone and shale along Indiana Highway 63 and 4.3 miles south of West Lebanon, Warren County, isn't a large one. But then northern Indiana doesn't have many rock exposures to choose from. This one is like an outpost with generally poorer collecting to the north. What it lacks in size is made up for in interest, with many lamp shells, corals, and sea-lily stems, especially in the shale below the more prominent limestone ledges. Here also is a treat for those who like to dabble in microfossils, for the shale has plenty of protozoans and ostracods. Treat it as I described for the fossils from the Salem Limestone (trail 17). The wheat-grain-shaped pro-



tozoans are especially interesting because they tell the paleontologist that this rock is the same age as that exposed near Des Moines, Iowa.

The highway turns southwest and parallels the Wabash River at a point 4 miles south of West Lebanon. Cross the first bridge (Redwood Creek) and stop at the second bridge 0.3 mile farther. The exposure is just northwest of the highway and on the west valley of a small stream (NE$\frac{1}{4}$ sec. 2, T. 20 N., R. 9 W.).

32. Fossils on the banks of the Wabash.—There's more than new mown hay on the banks of the Wabash--fossils too. It's no coincidence that my selected fossil trails for northern Indiana are concentrated near the river. Just as I said earlier, stream banks and bluffs are good places to look for fossils, because more of the overlying soil and Ice-Age deposits have been eroded. At this particular site, Mississippian shale is near enough to the surface that it is used economically by the Porter-Herron Brick Co. of Attica, Fountain County. You'll find good fossils in their shale pit 1 mile northeast of Attica, south of the secondary road, and near the Wabash Railroad tracks (SE$\frac{1}{4}$ sec. 32, T. 22 N., R. 7 W.).

33. Almost as good as a time machine.—Hoosiers need no out-of-state hunting license to collect from the coal mine dumps near Braidwood, Illinois. These dumps have provided plant fossils to collectors and museums throughout the world for more than 100 years. The fossil plants, with their delicate structures preserved as imprints, are found in rounded nodules that can be picked up in Mazon Creek and in the several square miles of dumps between the creek and Braidwood in Will and Grundy Counties. Allow yourself several hours for wandering over a small portion of the collecting area that begins on either side of U. S. Highway Alternate 66 just northeast of Braidwood and extends northwestward (Wilmington and Coal City Quadrangles). As he cracks open the nodules, the imaginative collector is amply rewarded with fine specimens, with such romantic names as *Cyclopteris, Asterotheca, Annularia,* and *Mixoneura,* which call to mind fleeting images of the Pennsylvanian coal swamp that flourished so long ago. The luckier collectors also find insects, spiders, worms, clams, fish scales, and parts of amphibians in the nodules, all of which give a pretty realistic picture of the strange life of that departed age.

The plant fossils are interestingly shown and described in "Leaves and Stems from Fossil Forests." (See the section called "Trail's End?")

34. Fossils from the Ice Age.—I can't tell you where to look for the spectacular fossil animals with backbones, because they're too hard to find. However, some of you "bugpickers"

from northernmost Indiana may not want to travel so far for the very ancient boneless fossils I have mentioned to this point. If so, do you know of a nearby marl pit? There are a great many in the northern tiers of counties. Marl is a limy shelly clay that is used mostly for agricultural lime. It is found in dried-up-lake deposits that were made during and after the retreat of ice northward from Indiana. The shells are mostly of tiny snails, but others such as clams and ostracods are found also. You should look closely in the marl for the shells before collecting, and then take a sack of marl home and concentrate the fossils as I described for the Carwood fossils (trail 20). The marl pits are too numerous to list; also, the exposures in marl pits commonly do not remain good for collecting a long time after a pit becomes inactive.

And if you southern Hoosiers think you'd like to look at these Ice-Age snails too, collect them from the yellow silt you see in the bluffs of the major river valleys, especially the Wabash and Ohio (trail 24, for example).

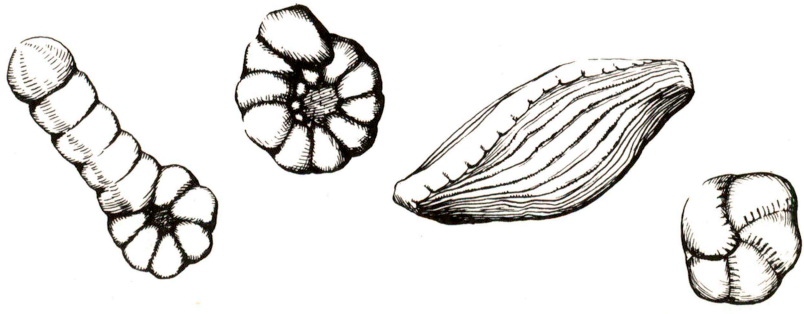
You can name most of these snails by looking at the "Fieldbook of Illinois Land Snails" and "The Mollusca of Michigan." (See the section called "Trail's End?")

THE KINDS OF FOSSILS IN INDIANA

ONE-CELLED ANIMALS (PROTOZOANS)

No doubt you are familiar with that shapeless (and yet of any shape) speck of protoplasm we call *Amoeba*, which consists of a single cell. Yet that one cell carries on all the functions of life--use of food, elimination of waste, reproduction, movement, and defence. Probably for *protective* purposes, one marine group of amoebalike protozoans, called *Foraminifera* or *forams*, developed the shell-building habit many millions of years ago. Their shells number as many kinds as the snowflakes, from the simplest tubes to complexly chambered designs. But each species always made the same shape, size, composition, and design of shell. Strange indeed that this most primitive of creatures should seem to have intelligence!

All of the fossil forams in Indiana are small but can be seen easily with a reading glass or binocular microscope. You can recover them best from the Mississippian and Pennsylvanian rocks for which I have mentioned tiny fossils. (See especially trail 17).

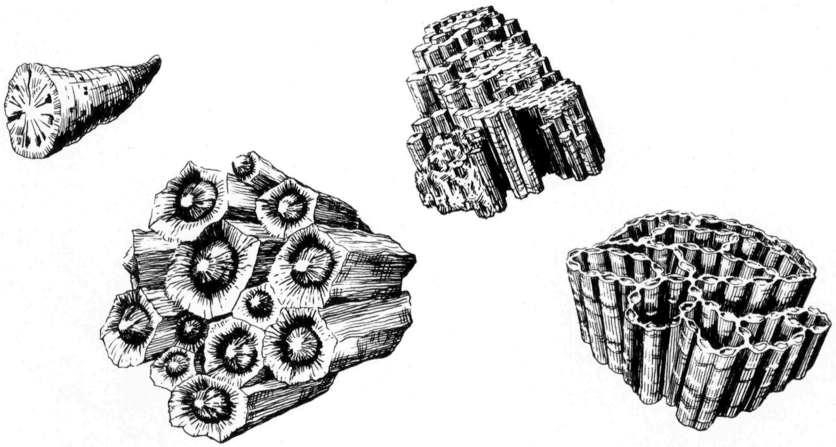


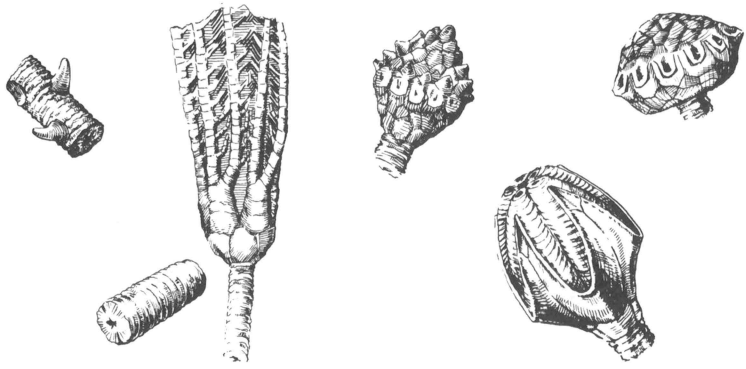
SPONGES (PORIFERA)

Whoever heard of washing your car with the skeleton of an animal? Yet you do, or at least did before they made "sponges" of rubber and plastic. You see, real sponges are animals that live today on the sea floor as they did also in the past. They are certainly primitive animals, and the simplest commonly are shaped like a vase with a large opening at top and many smaller ones through the walls. The soft stuff of their walls is supported by a skeletal network of tiny stiff or flexible rods. The rods are of different shapes and materials in different sponges. Fossil sponges from Indiana don't look much like the modern sponge you know about; they are small and are shaped somewhat like Christmas trees, saucers, or rounded stones. One kind has star-shaped rods in its skeleton. In Indiana, sponges are more common in Silurian and Devonian rocks, but you will not find them at many places.

CORALS (ANTHOZOA)

The scientific name for corals is a good one because *Antho-zoa* means flower-animals. Anyone who has seen the vivid colors of a living reef and the single animals of which the reef is made has no trouble in understanding. You see, many corals have both hard and soft parts which are placed radially about the mouth and stomach so that they look something like a daisy when seen from above. Modern corals have tentacles with stinging cells for protection and food gathering, but of course we see only the skeletons preserved in fossil corals. Many corals lived together, as at present, so that one fossil may be made of many corals. Thus we find honeycomb and chain corals; other corals lived singly, as did the horn corals. Fossil corals are so abundant in Indiana that collecting spots are too many to list. In fact, some rock layers are largely coralline and show that corals built reefs hundreds of millions of years ago just as they do today.



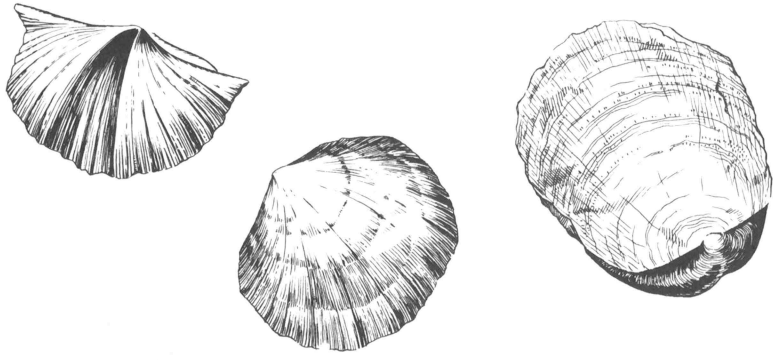


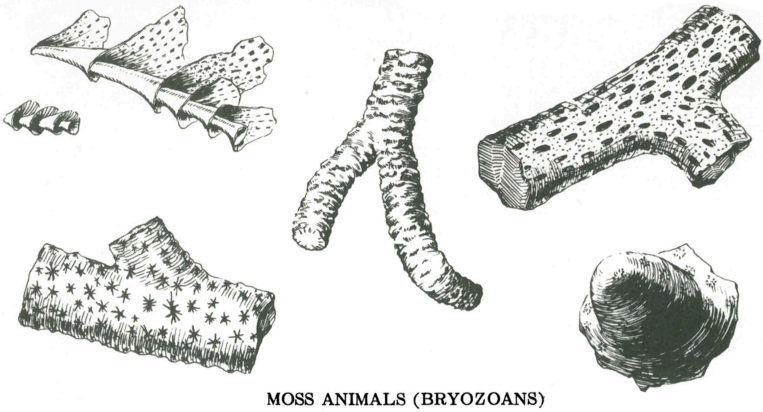
SEA LILIES AND SEA BUDS (CRINOIDS AND BLASTOIDS)

These strange animals look more like flowers, and hence their names: *crin-oid,* meaning lilylike, and *blast-oid,* meaning budlike. Perhaps you have collected the disc-shaped plates of their stems and called them "Indian beads." Yes, most had stems by which they anchored themselves to the bottom of the sea or to some object. Most of the soft parts were in a globular bowl, made of hard plates, on top of the stem. "Arms" extended outward and upward from the bowl or "head" and further made the animals look like flowers. Sea lilies still live today but are scarce. In the past, both animals flourished in the seas that spread over Indiana as shown by some limestones which are composed mostly of stems and plates. (See trails 13 and 14.)

LAMP SHELLS (BRACHIOPODS)

Some brachiopods are supposed to look like an old Roman lamp, but I think they look more like clams. Living lamp shells have two hinged half shells that are opened and closed by strong muscles. They are also like some marine clams because they fix themselves to objects on the bottom of the sea. You can tell the two apart because the two half shells of a lamp shell are of different shape and size; the two half shells of a clam are alike in shape and size. (Also, clams are better eating.) Many fossil lamp shells have riblike ridges; some have spines or bumps on the shell. Lamp shells are among the most common fossils in Indiana and can be found at nearly every site listed. The numbers of different kinds appear to be endless.



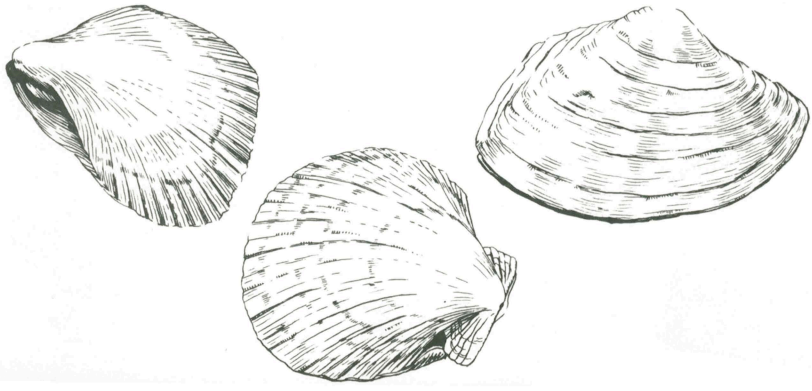


MOSS ANIMALS (BRYOZOANS)

Moss animals are little-noticed animals that live mostly in the seas today as well as neglected fossils that can be found in most marine rocks. However, their great abundance hardly explains either fact. The soft part of a moss animal is something like that of a lamp shell, but its habit is more like that of a coral. It builds a calcareous skeleton about itself, and it is colonial. Each animal is very tiny, and its skeletal tube is about the size of a needle hole. Thus, thousands, even millions, live together in one colony, and it is the colony that we see as fossils. Some colonies are crusts on rocks and shells; others are rounded mounds; still others are branching and look like a leafless plant or the antlers of a deer. Most fossils in Indiana rocks can be identified by these shapes and by the thousands of pinpricks all over the surface. One other kind, especially in rocks of Mississippian age, is made of lacy fronds around a corkscrew column and is certainly a beautiful fossil. Moss animals largely make up the bulk of some limestones. For good collecting, see especially trail 3, but they are abundant at many places.

CLAMS (PELECYPODS)

Clams are cousins of the oyster and live today in the sea and in fresh waters. Perhaps you have dug them from a river bank or beach. Of course, a clam has two half shells that are opened and closed by strong muscles. Look straight upon the surface of a clam shell and see how it lacks the balance of a lamp shell. However, see how the two half shells of a clam are alike. Many clam shells have



strong growth lines paralleling the edges of the shells; others have ridges and spines. Fossil clams from Indiana lived much as do modern clams and oysters, but I have not yet heard of fossil pearls! Their shells are found at many places, but rarely are they the most abundant fossil.

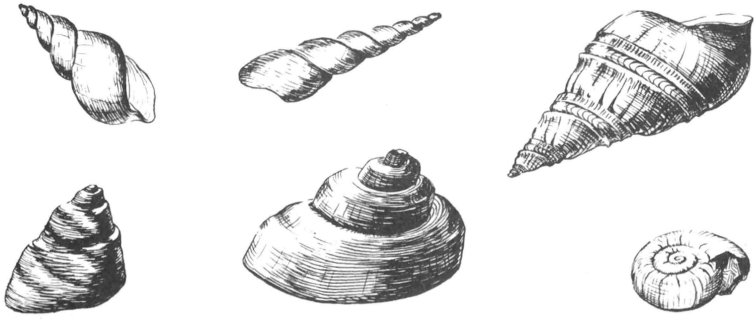
SNAILS (GASTROPODS)

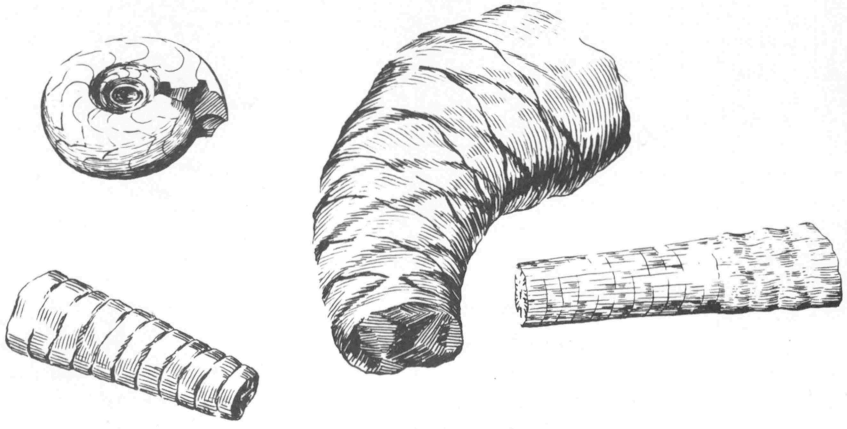
You are probably most familiar with the kind of snail you see in fishbowls, but other snails live today in trees, on the ground, in fresh water, and in the sea. The large conch in which you hear the roar of the sea when you hold it to your ear is a good example of one that never lived in a fishbowl. Fossil snails are numerous and of many kinds in Indiana. They can be identified easily in your collection by their undivided tubes, which are coiled in a spire, small at one end and large at the open end. The spires are of many shapes and sizes, and some have beautiful ornamentation in the form of ridges, growth lines, and spines or bumps. The Salem Limestone is perhaps the best rock in Indiana for many kinds of tiny snails. (See trails 17 and 18.)

ANCESTORS TO THE PEARLY NAUTILUS (CEPHALOPODS)

Build thee more stately mansions, O my soul,
As the swift seasons roll!
Leave thy low-vaulted past!
Let each new temple, nobler than the last,
Shut thee from heaven with a dome more vast,
Till thou at length art free,
Leaving thine outgrown shell by life's unresting sea!

The subject for these timeless words by Oliver Wendell Holmes was well chosen. For the pearly nautilus of today's seas indeed must have noble virtues to be the only survivor of a race of shelled cephalopods that began hundreds of millions of years ago in Ordovician seas. The words of Holmes have deeper meaning, but they also tell of the nautilus' habit of adding new chambers to its shell as the animal grows. Perhaps you know more about the pearly nautilus' cousins, the octopus and squid. They are shell-less cephalopods and give you a good idea of the soft parts of the pearly nau-



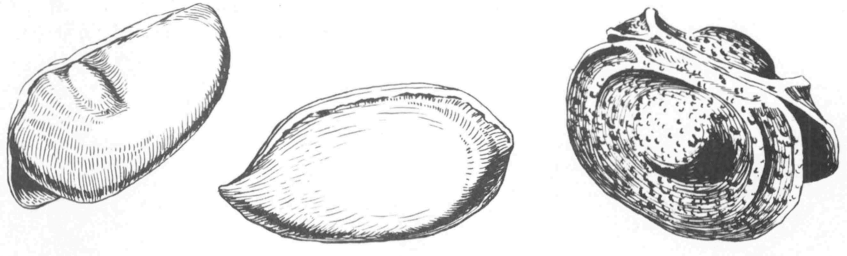


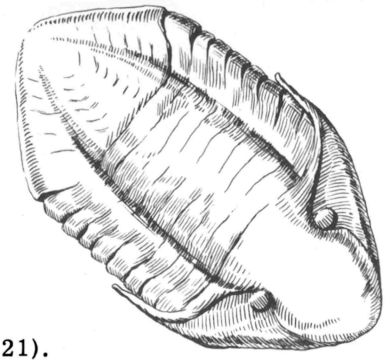
tilus and its ancestors of so long ago. Many kinds of fossil cephalopods are found in Indiana rocks, from very small forms to some 15 to 20 feet long, and from straight, cone-shaped specimens to those which are tightly coiled like a watch spring. Most of them show the division into chambers.

JOINT-LEGGED ANIMALS (ARTHROPODS)

Yes, that's what *arthro-pod* means, "jointed-leg," and you know of many arthropods that live today--insects, spiders, centipedes, and various shelled animals called *crustaceans*, including barnacles, crabs, crayfish, lobsters, and shrimp. Not only do these animals have jointed legs, but their bodies are segmented. Those which do not have hard outer shells at least have stiff ones made of stuff called *chitin*, which you see in the pincers of a beetle. Jointed-legged animals have a long fossil record, but it is not an abundant one in Indiana except for two groups about which I will tell you. They are ostracods and trilobites; perhaps you have heard of neither.

Ostracods are tiny crustaceans, most no longer than the thickness of a pencil lead, that live in all kinds of fresh and marine waters, even in mud puddles. You can strain them out of ponds with a cloth net and keep them for a while in bowls. They look something like clams because they have two hard half shells that are hinged and are operated by muscles. You can tell them from baby clams because of their legs; most importantly, if they are fossilized, their shells have no growth lines as do clam shells. Ostracods are in most fossiliferous rocks in Indiana and are among the most abundant microfossils. Their shells, like those of forams, number as many kinds as the snowflakes. Some grew to an inch or more in length. Ostracods can be recovered easily from the Salem Limestone (trails 17 and 18) and from the black shale in the Lutgring and Sons quarry





(trail 21).

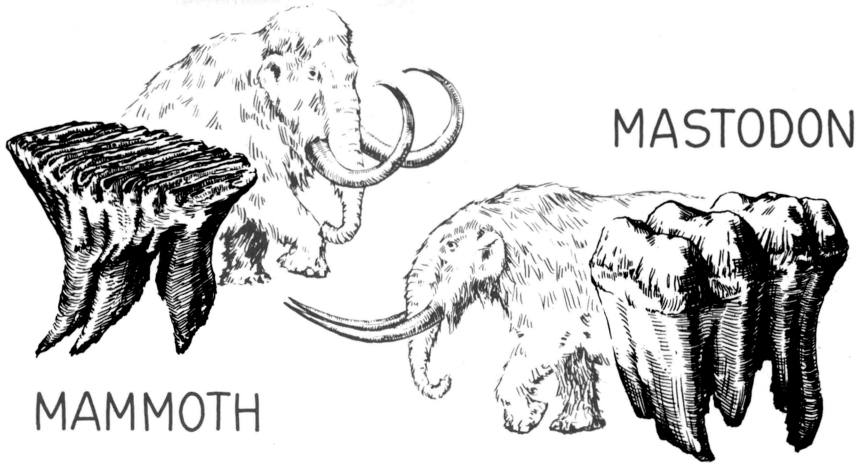
Tri-lobite means one of "three lobes" and refers to the division of the body from front to back into three parts; trilobites also are divided into three parts from side to side. So like other arthropods, these animals are segmented and once had chitinous skeletons and jointed legs, but they are still unfamiliar to you because they are extinct and known only as fossils. They were scavengers in the seas, swimming, crawling, or grubbing. Most fossil trilobites are an inch or two long, but some are more than 2 feet in length. Trilobites are among the most prized of fossils but are not very common. Ordovician and Silurian rocks are best for trilobites in Indiana.

ANIMALS WITH BACKBONES (VERTEBRATES)

When the word "animal" is mentioned, perhaps you think first of animals with backbones such as the gopher, beaver, deer, and elephant. My neglect of these may seem strange at first until you realize that most of the fossiliferous bedrock of Indiana was made in the sea. Still, I haven't even discussed fish, which surely were abundant in the seas when our rocks were made. That's true, but they were simple fish without hard bony skeletons which are easily fossilized. So mostly we find only their teeth or scales, or armor plates of extinct forms, but even these are not common.

Thus, in Indiana you must be content with fossils that mostly are of animals without backbones (invertebrates). Look inside the front cover at the geologic timescale, and you learn another reason for this. Most kinds of the backboned animals of today didn't live at all between the Ordovician and Pennsylvanian Periods when most of our available rock was made. There were fish and a few amphibians at that time, but no reptiles, birds, mammals, or men.

There is one notable exception, however. Indiana does have unhardened rock material that was deposited during the Ice Age as a thin cover over the hard bedrock throughout most of the state. The direct ancestors of modern backboned animals lived during the Ice Age, and some are found as fossils in the glacial cover. Although such finds may be spectacular, it is hardly worth the average collector's time in Indiana to hunt for them. Their discovery is generally by chance, in excavations made in gravel and marl pits or in



peat bogs. If you hear of a discovery, then go after it. Notify a geologist if it seems very important.

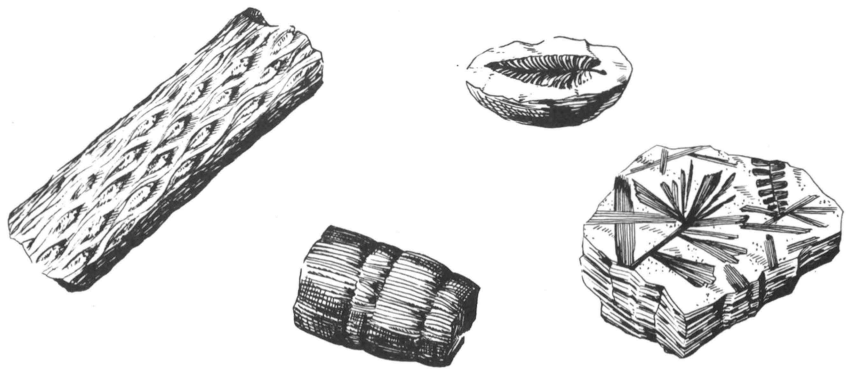
Some of the most interesting finds of Ice-Age fossils in Indiana are of the modern elephant's very near relatives, the great mammoth and mastodon. Complete skeletons may be seen in museums, but new finds in the field are rare; teeth are more common. Note the differences between mastodon and mammoth teeth.

You can read more about Indiana's vertebrate fossils in "The Geological History of the Vertebrates of Indiana." (See the section called "Trail's End?")

PLANTS

After reading my descriptions of some fossil animals that look like plants, you may wonder what a plant is. Do all plants have roots? That won't do at all. In fact it's pretty hard to say in one or two sentences. I think "Plants use carbon dioxide, water, and sunlight in order to make the stuff of plants" comes close to saying what a plant is, but that doesn't catch them all. For example, the fungi live on the ready-made food of other plants. With such a broad description, and including the fungi, you can understand that plants are fully of as many kinds as animals. They are from microscopic size to tree-size and live on soil, rocks, other plants, and in fresh and salt water. This was true in the geologic past too.

So far as we know, plants have lived on the earth at least as long as animals, and they are far more abundant as fossils than we



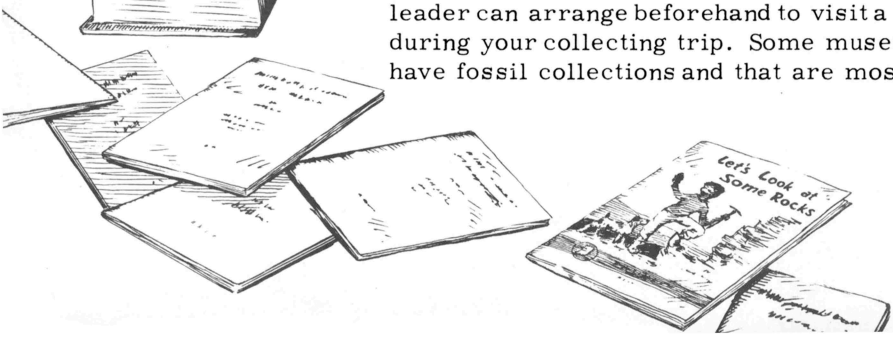
realize, even in marine rocks. Some limestones are made mostly of the hard secretions of algae. You know about algae as seaweed and as the green "scum" in ponds and horse troughs. The rock we call *coal* is made of carbonaceous remains of plants, and therefore coal itself is a fossil.

Of course, you are more interested for the moment in single plant fossils you can collect rather than in a chunk of coal or limestone, even if they are fossils. In Indiana the coal-bearing rocks of Pennsylvanian age are much the best. During that period of time there were none of the palms, cereal grains, flowering shrubs, trees, and flowers that are so much around us today. Yet plants were abundant and grew in dense coal-making forests. The largest were giant scale trees more than 100 feet tall. A pattern of scars marks the points where leaves grew out from the trunk. I once traveled 200 miles to look at a huge fossil "snake" some quarrymen told me about. You're right; it proved to be a scale tree. Other trees were jointed like bamboo and the rushes of modern swamps. Unlike rushes, they grew to great heights. Perhaps most easily found in Indiana are the beautiful fossil leaves of many kinds of ferns and seed ferns (trails 25, 26, and 33).

TRAIL'S END?

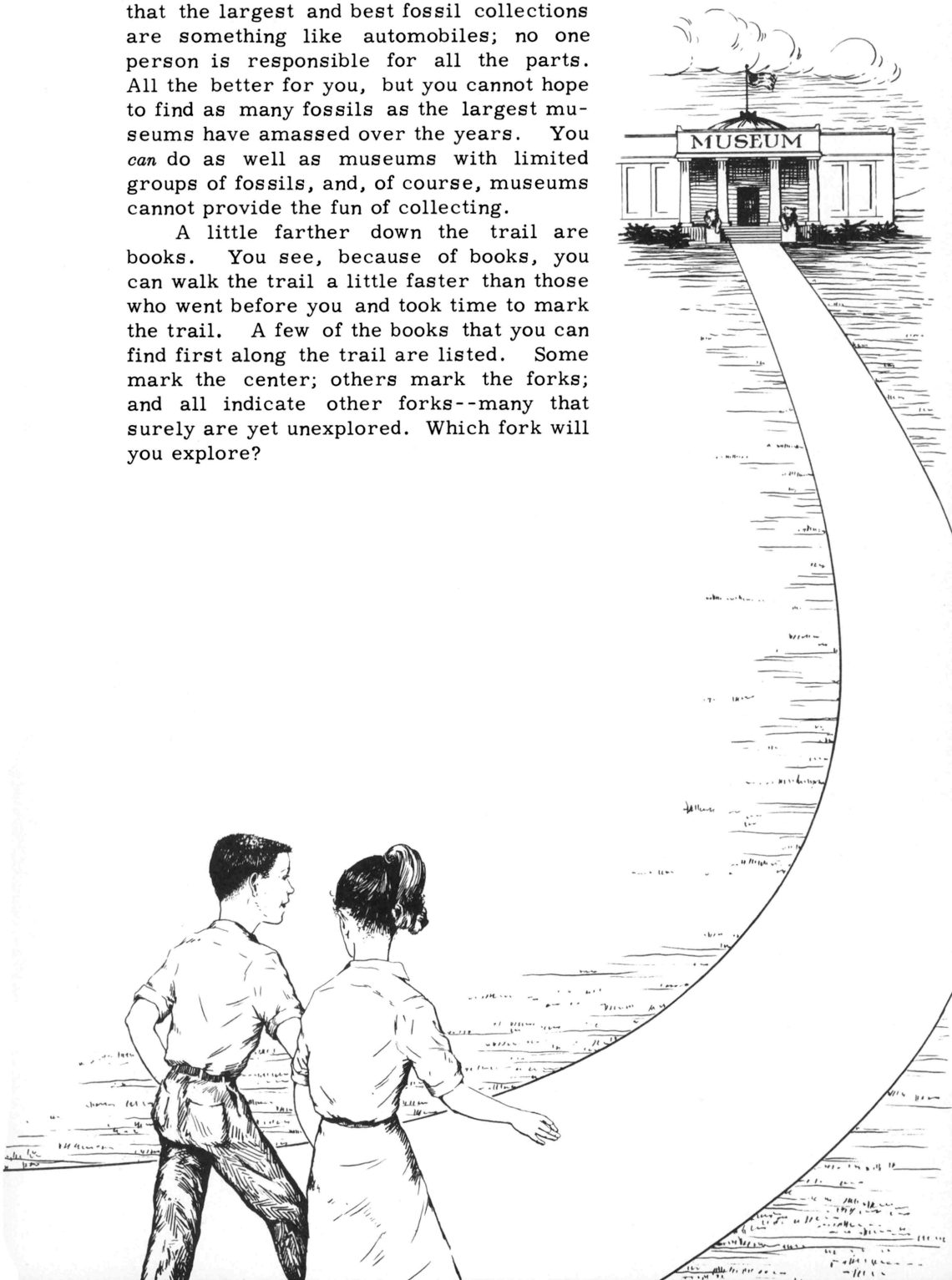
Actually, the fossil trail never ends for those who follow it earnestly. It is a trail of learning that stretches farther than any eye has power to see, and its forks are more than any leg has time to walk. But along the trail are many places for pause, reflection, fun, adventure, and reward. The trail has barely begun where you collect your fossils, and now you may want to study, name, or display them.

You can learn and get many ideas in the museums that are just down the trail a little way from the collecting sites. Perhaps your group leader can arrange beforehand to visit a museum during your collecting trip. Some museums that have fossil collections and that are most acces-



sible to Hoosiers are listed. Remember that the largest and best fossil collections are something like automobiles; no one person is responsible for all the parts. All the better for you, but you cannot hope to find as many fossils as the largest museums have amassed over the years. You *can* do as well as museums with limited groups of fossils, and, of course, museums cannot provide the fun of collecting.

A little farther down the trail are books. You see, because of books, you can walk the trail a little faster than those who went before you and took time to mark the trail. A few of the books that you can find first along the trail are listed. Some mark the center; others mark the forks; and all indicate other forks--many that surely are yet unexplored. Which fork will you explore?



MUSEUMS ALONG THE TRAIL

CHICAGO NATURAL HISTORY MUSEUM

CHILDREN'S MUSEUM, Indianapolis

UNIVERSITY OF CINCINNATI MUSEUM

CINCINNATI MUSEUM OF NATURAL HISTORY

DEPAUW UNIVERSITY, Department of Geology, Greencastle

EARLHAM COLLEGE, Joseph Moore Museum, Richmond

HANOVER COLLEGE, Department of Geology, Hanover

INDIANA UNIVERSITY, Departments of Geology and Botany, Bloomington

UNIVERSITY OF LOUISVILLE, Department of Geology

LOUISVILLE NATURAL HISTORY MUSEUM

MIAMI UNIVERSITY, Department of Geology, Oxford, Ohio

UNIVERSITY OF NOTRE DAME, Department of Geology, Notre Dame

PURDUE UNIVERSITY, School of Civil Engineering, Lafayette

ST. JOSEPH COUNTY HISTORICAL SOCIETY MUSEUM, South Bend

ST. JOSEPH'S COLLEGE, Department of Geology, Rensselaer

WABASH COUNTY HISTORICAL SOCIETY MUSEUM, Wabash

BOOKS, THE TRAIL MARKERS

ALONG THE HILL. Carroll Lane Fenton. Reynal & Hitchcock, New York, 1935. $2.75.

A fascinating little book on geology, especially for use of children in understanding the rocks and fossils they can see on hikes. Grade school.

GUIDE FOR BEGINNING FOSSIL HUNTERS. Charles W. Collinson. Illinois Geological Survey, Educational Series 4, Urbana. 25 cents.

An elementary introduction to the Paleozoic fossil plants and animals without backbones that can be found in Illinois (and Indiana), together with useful tips for the collector. Grade school and up.

PREHISTORIC WORLD. Carroll Lane Fenton. John Day, New York, 1954. $3.00.

Well-illustrated stories of animal life in past ages. Grade school.

PREHISTORIC AMERICA. Anne Terry White. Random House, Inc., New York, 1951. $2.50.

Stories on how geologists worked out the geological history of America and its life. Grade school.

ALL ABOUT STRANGE BEASTS OF THE PAST. Roy Chapman Andrews. Random House, Inc., New York, 1956. $1.95.

About prehistoric mammals and the adventures of a paleontologist while hunting fossils. Grade school.

PREHISTORIC ANIMALS. Josef Augusta. Spring Books, London, 1957. $4.20.

An imaginatively written introduction to the history of all kinds of life, especially of the animals with backbones. The 60 large, striking, and beautiful illustrations, together with accompanying descriptions, make this book a standout for all ages.

PREHISTORIC ANIMALS. William E. Scheele. World Publishing Co., Cleveland, 1954. $4.95.

Here is another beautifully illustrated geologic history of life, except mammals, and a standout for all ages.

LIFE THROUGH THE AGES. Charles R. Knight. Alfred A. Knopf, New York, 1951. $3.00.

Stories on the development of many kinds of life from the Cambrian Period on, presented by striking illustrations, each accompanied by an explanatory text. For all ages.

THE FOSSIL BOOK; A RECORD OF PREHISTORIC LIFE. Carroll Lane Fenton and Mildred Adams Fenton. Doubleday, Garden City, New York, 1958. $12.50.

This wonderfully illustrated book systematically treats of most kinds of fossils. One of the most interesting and complete. High school and adults.

HOW FATHER TIME CHANGES THE ANIMALS' SHAPES. Gaylord Johnson. Messner, New York, 1939. $2.00.

A simplified explanation of how evolution works. Advanced grades and junior high.

LIFE LONG AGO. Carroll Lane Fenton. Reynal & Hitchcock, New York, 1937. $6.00.

The story of all kinds of fossils. Advanced grades and high school.

THE STORY OF OUR EARTH. Richard Carrington. Harper & Brothers, Publishers, New York, 1956. $3.00.

A nontechnical history of life from its beginning to civilization. High school and adults.

FOSSILS: PREHISTORIC ANIMALS IN HOOSIER ROCKS. T. G. Perry. Indiana Geological Survey Circular __, Bloomington. In preparation.

An introduction to the fossils of Indiana with many plates and discussions, especially useful to collectors for study and identification of invertebrate fossils of Paleozoic age. List of 20 collecting localities in Indiana. High school and adults.

LIFE OF THE PAST. George Gaylord Simpson. Yale University Press, New Haven, 1953. $4.00.

A nontechnical introduction to paleontology that is especially interesting because it treats of the significance of the science. Advanced high school and adults.

ANCIENT PLANTS AND THE WORLD THEY LIVED IN. Henry N. Andrews, Jr. Comstock Publishing Co., Inc., Ithaca, New York, 1947. $4.50.

An easily read and thorough treatment of the geologic history of plants. High school and adults.

OHIO FOSSILS. Aurele La Rocque and Mildred Marple Fisher. Ohio Geological Survey Bulletin 54, Columbus, 1955. 97 cents.

A nontechnical introduction to Ohio fossils. Especially useful to the collector for giving scientific names to Ohio fossils, most of which are also found in Indiana. Extensive bibliography of professional work on fossils.

ELEMENTARY GUIDE TO THE FOSSILS AND STRATA OF THE ORDOVICIAN IN THE VICINITY OF CINCINNATI, OHIO. Kenneth E. Caster and others. Cincinnati Museum of Natural History, 1955.

You can name nearly all of your Ordovician fossils collected in Indiana by using this popular guide.

THE MOLLUSCA OF MICHIGAN. Calvin Goodrich. University of Michigan, University Museums, Michigan Handbook Series No. 5, Ann Arbor, 1932. $1.00.

You can name most of your snails and clams collected from the marl pits of northern Indiana by looking at this book.

FIELDBOOK OF ILLINOIS LAND SNAILS. Frank C. Baker. Illinois Natural History Survey Manual 2, Urbana, 1934. $1.00.

You can name most of your Ice-Age snails by using this book.

INDEX FOSSILS OF NORTH AMERICA. H. H. Shimer and R. R. Shrock. John Wiley & Sons, Inc., New York, 1944. $22.00.

The Paleontologists' "Bible" names, illustrates, and describes briefly most of the important fossil animals without backbones. Full bibliography on professional work on fossils. Useful to the most serious collector for identifying fossils.

THE GEOLOGICAL HISTORY OF THE VERTEBRATES OF INDIANA AND THEIR POSITION IN THE ANCIENT NORTH AMERICAN FAUNA. R. L. Moodie. Indiana Division of Geology Publication 90, Bloomington, 1929. Cloth, 50 cents; paper 25 cents.

A nontechnical geological history of the animals with backbones in Indiana from the Devonian Period to the present. High school and adults.

FOSSIL PLANTS OF INDIANA. James E. Canright. Indiana Geological Survey Report of Progress 14, Bloomington. In preparation.

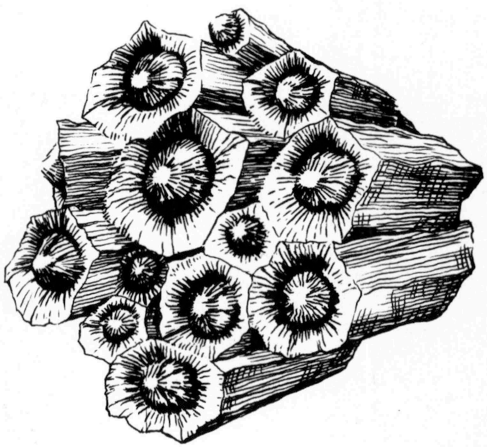
You can name nearly all of your fossil plants of Pennsylvanian age from Indiana by looking at this book.

LEAVES AND STEMS FROM FOSSIL FORESTS. Raymond E. Janssen. Illinois State Museum, Popular Science Series, v. 1, Springfield, 1939. $1.25.

You can name nearly all of your fossil plants of Pennsylvanian age obtained from nodules by looking at this popular guide.

EARTH FOR THE LAYMAN. Mark W. Pangborn, Jr. American Geological Institute Report 2, Washington, D. C., 1957. $1.00.

Contains 1,370 titles of books concerning geology for nongeologists who are 8 years of age and up. More than 90 items deal with fossils. The items are classified according to subject matter and age group, and many are annotated. Publishers and prices are given.



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JOHN B. PATTON, Principal Geologist
BERNICE M. BANFILL, Administrative Assistant to the State Geologist
MARY BETH FOX, Mineral Statistician

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S. A. FRIEDMAN, Geologist
HENRY H. GRAY, Geologist
HAROLD C. HUTCHISON, Geologist
RICHARD C. NEAVEL, Coal Petrographer
LARRY LAWRENCE, Geological Assistant

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MICKY P. LOVE, Geological Draftsman
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JERRY B. FOX, Assistant Driller
ARTHUR WAYNE AYNES, Geophysical Assistant

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JAMES CAZEE, Geological Assistant
PHILLIP W. CAZEE, Geological Assistant

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