3. Fossils

Fossils represent a merger between the sciences of geology and biology. They are at the core of the science of paleontology, or the study of past life. To study fossils, you need to learn about different forms of life on earth, the history of that life, and the geological processes that preserve life's record. The following activities will assist you. As a start, you should get a book. There are many good, basic guidebooks at reasonable prices, such as Rhodes, Zim, and Shaffer's *Fossils: A Guide to Prehistoric Life*, Palmer's *Pockets Fossils*, Walker and Ward's *Smithsonian Handbooks: Fossils*, and more. You can also find many good books like these in your public library.

Activity 3.1: The geological time chart.
Memorize the geological eras and periods and some key facts about each one. Then make a geological time line showing all the geological periods on a long sheet or roll of paper. Illustrate it with drawings of fossils and prehistoric plants and animals that are characteristic of each period.

Activity 3.2: Types of fossilization and making or excavating fossils.
Explain the different types of fossilization (e.g., carbonization, mineralization, molds and casts, etc.). Then do one of the following. Make a "fossil" with clay and plaster, make paper or cardstock cut-and-fold fossil models, bake a Tri-lo-"Bite," make a sponge fossil bone, make artificial amber with insects, or excavate a real or plastic fossil.

Activity 3.3: The forms of life.
Demonstrate knowledge of the major groups of invertebrates, vertebrates, and plants.

Activity 3.4: Collecting fossils.
Build a fossil collection of 10 to 20 specimens. Some collectors concentrate on a single sort of plant or animal (for instance, trilobites) and try to collect a wide range of species. Others concentrate on one locality or formation and build an array of all the plants and animals that locality has to offer. Still others opt for diversity, trying to collect a little bit of everything (clams, brachiopods, corals, shark teeth, trilobites, etc.). Whichever form you choose, be sure to follow the basics of good curation, labeling each specimen and keeping a log book with key information (what it is, where it came from, age of the fossil, etc.). (See Badge 5: Collecting.)

Activity 3.5: A fossil-collecting field trip.
Learn and demonstrate knowledge of the AFMS Code of Ethics and the rules of field trip etiquette (as well as the laws of your state or region), then head out on a fossil-collecting trip. (See Badge 8: Field Trips.)

Activity 3.6: Your state fossil.
Just as each state has its own flag, many have an official state fossil. Find out what your state fossil is and write a report about it for your club newsletter or talk about it at one of your meetings. If your state doesn't have a state fossil, discuss what would be a good fossil to nominate, and then write to your governor or local state legislature to suggest it!

Activity 3.7: Dinosaurs.
Everyone loves one particular fossil: dinosaurs! With your fellow club members, take part in a dinosaur identification game or other dinosaur-related activities, such as crafting cut-and-fold paper or cardstock dinosaur models.

Activity 3.8: Fossil and dinosaur names.
Fossils, including dinosaurs, often have long names that seem impossible to pronounce. Sometimes, they were built around the name of a person (for instance, a famous paleontologist or the person who first discovered the fossil). Other times, they are named for the place where they were found or for some characteristic. The names are then put into Latin or Greek form. Pick your favorite fossils or dinosaurs and learn how its name came about and what it means. Or develop a new dinosaur name built around the name of your society or town. Or create a whole new fossil animal and give it a name!

3. Fossils

□ 3.1 The geological time chart

□ 3.2 Types of fossilization and making or excavating fossils

□ 3.3 The forms of life

□ 3.4 Collecting fossils

□ 3.5 A fossil-collecting field trip

□ 3.6 Your state fossil

□ 3.7 Dinosaurs

□ 3.8 Fossil and dinosaur names

To earn your Fossils badge, you need to complete at least 3 of the 8 activities. Check off all the activities you've completed. When you have earned your badge, sign below and have your FRA leader sign and forward this sheet to the AFMS Juniors Program chair.

_____
Date completed

_____ _____
My signature Youth leader's signature

_____
Name of my club

Leader's preferred mailing address for receiving badge:

_____

_____

_____

Back-up page for Fossils badge: Reference books.

Following are some books kids might buy or seek in the library for learning about fossils:

- Horenstein, *Familiar Fossils*, the Audubon Society Pocket Guides (1988)
- Ivanov, et al., *The Complete Encyclopedia of Fossils* (2001)
- Mehling, *Fossils: 300 of the Earth's Fossilized Species* (2007)
- Palmer, *Fossils*, Pockets Series (2004)
- Rich, Rich, Fenton & Fenton, *The Fossil Book: A Record of Prehistoric Life* (1997)
- Rhodes, et al., *Fossils: A Guide to Prehistoric Life*, Golden Guides Series (1962)
- Thompson, *The Audubon Society Field Guide to North American Fossils* (2002)
- Walker & Ward, *Fossils*, Smithsonian Handbook Series (2002)

The little paperback by Rhodes and the much bigger book by Rich, Rich, Fenton & Fenton are classics that were standards way back when I was a kid! In addition to these, I encourage you to check out three other books that tell all about fossils and how to become a fossil detective, one geared to very young children, another to kids in grades 3-5, and the other to still older kids:

- Aliki's *Fossils Tell of Long Ago* (1990) is a story book that introduces young children to fossils: what they are, how they formed, how they are found, what they tell us, and how to make a fossil of your own.
- Jenny Fretland VanVoorst's *Fossils* (2015) is part of Abdo Publishing's Core Library Rocks and Minerals Series geared to kids in grades 3-5.
- Peter Larson and Kristin Donnan teamed to write *Bones Rock! Everything You Need to Know to Be a Paleontologist* (2004). This is a fantastic, beautifully illustrated introduction for somewhat older kids. Paleontologist Robert Bakker says it best on the back cover of the book: "A wonderfully generous invitation to the joys of paleontology! This is the book I wish I had when I was ten. And fifteen. And in college. And when I got my first job teaching paleontology. *Bones Rock!* tells you how to be a dino detective. Listen carefully."

You can find these and other guidebooks in the Science, Nature, and Field Guide sections of bookstores. You can sometimes get guidebooks like these at a discount if ordering in bulk and if your club has a nonprofit, educational tax ID number and you let the distributor know you're purchasing for educational purposes.

Finally, many interesting websites help you explore fossils with kids, like the following:

- National Park Service Junior Paleontologist Program
  http://nature.nps.gov/geology/paleontology/jr_paleo.cfm
- "The Learning Zone," Oxford University Museum of Natural History
  http://www.oum.ox.ac.uk/thezone/fossils/index.htm
- University of California Museum of Paleontology
  http://www.paleoportal.org

Back-up page 3.1: The geological time chart.

It took humans a long, long time to fully appreciate the long, long history of our planet Earth. As that appreciation dawned, scientists began constructing stratigraphic and geologic time scales and charts. Today, an International Commission on Stratigraphy researches official names, dates, and ages to set a consistent and uniform chart that serves as the go-to reference source for academic and professional researchers and students. Work with your kids to learn about the geological time chart and the different plants and animals that lived during the different eras and periods.

A basic geologic time chart, with examples of common fossils from each period, is provided on the next page as a reference. In addition, a similar table with blank spaces is provided for kids to fill in the era, period, and epoch names.

Alternatively, you can encourage your kids to create their own timeline in whatever way they like. For instance, some kids prefer a horizontal timeline, illustrating it to show different creatures that supplanted one another through time. If you get a long roll of large paper, this also makes a neat group activity. Roll the paper the entire length of a room and divide it up into the geological time scale. Then pass out pencils, colorful markers and crayons, and assign kids to different periods to illustrate with fossils and reconstructions of plant and animal life of those periods.

Finally, another neat activity for illustrating the vast scale of geologic time is to make a timeline in chalk on a sidewalk with one inch equaling one million years. (Thus, to go from the beginning of the Cambrian Period to the present, your time line would stretch 544 inches, or more than 45 feet! And that's ignoring the preceding four *billion* years of earth history—for that, you'll need a bigger piece of chalk!) Give kids pieces of colored chalk to draw pictures of appropriate fossils at different spots along the timeline, with trilobites in the Cambrian, dinosaurs in the Jurassic, and so forth.

A website related to the geological time scale, along with some animations, has been put together by the Planet Habitability Laboratory of the University of Puerto Rico: http://phl.upr.edu/library/notes/thedistributionofcomplexlifeinthelast540millionyears

ERA	PERIOD/EPOCH		
Cenozoic "recent life" dinosaurs dead / mammals ahead mammals diversify first humans	**Quaternary** (modern humans appear; mastodons & mammoths & other Ice Age mammals)		**Holocene** *11,000 years* **Pleistocene** *1.6 million years*
	Tertiary (by the Eocene, many modern types of mammals appear, including whales; large running mammals appear in Oligocene; large carnivores and grazing mammals are abundant starting in the Miocene; earliest hominids appear in late Miocene or early Pliocene)	**Neogene**	**Pliocene** *5.2 million years* **Miocene** *23 million years*
		Paleogene	**Oligocene** *35 million years* **Eocene** *56 million years* **Paleocene** *65 million years*
Mesozoic "middle life" dinos rule / mammals drool first dinosaurs & first mammals appear toward end of Triassic Era ends in great mass extinction (end of dinosaurs) likely caused by asteroid impact	**Cretaceous** (earliest placental mammals; earliest flowering plants; bony fish proliferate; dinosaurs and ammonites proliferate but become extinct by the end of the period) *145 million years before present*		
	Jurassic (dinosaurs are abundant on land and ammonites in the sea; earliest birds) *208 million years before present*		
	Triassic (earliest dinosaurs & mammals; cycads & conifers diversify) *245 million years before present*		
Paleozoic "ancient life" invertebrates reign supreme Cambrian "explosion" ushers in complex multicellular life First land plants as early as Ordovician First land vertebrates and rise of seed plants toward end of Devonian Era ends in largest mass extinction in earth history; cause still unknown	**Permian** (mammal-like reptiles emerge; largest mass extinction event on earth) *290 million years before present*		
	Pennsylvanian (great coal-forming forests of scale trees & seed ferns; abundant insects) *323 million years before present*		
	Mississippian (abundant sharks & amphibians & crinoids; earliest reptiles) *362 million years before present*		
	Devonian (fish become abundant; extinction of armored fish; earliest amphibians and ammonoids) *408 million years before present*		
	Silurian (great diversity of ostracods; earliest land plants and insects) *439 million years before present*		
	Ordovician (graptolites abundant; invertebrate marine animals proliferate, especially coelenterates, mollusks, brachiopods, bryozoans, and arthropods) *510 million years before present*		
	Cambrian (appearance of burrowing animals and most contemporary forms of complex multicellular life; trilobites common) *544 million years before present*		
Pre-Cambrian Divided into **Proterozoic Eon** (2.5 to .54 billion years ago), **Archean Eon** (3.8 to 2.5 billion years ago), and **Hadean Eon** (starting 4.6 billion years ago, when earth formed)	**Vendian** or **Ediacaran** (enigmatic soft-bodied Ediacaran fossils appear shortly before the Cambrian) *600 million years before present*		
	(Single-celled life emerges and proliferates: bacteria, algae, stromatolites) *4.6 billion years before present*		

ERA	PERIOD/EPOCH		
		—	

Back-up page 3.2: Types of fossilization and making or excavating fossils.

Forms of Fossilization.

Fossils are the preserved remains or evidence of past life, both plant and animal, microscopic and macroscopic. These include actual remains of the plant or animal (such as teeth), carbonized impressions, molds and casts of shells and other body parts, etc., as well as evidence of an organism's activity, such as chemical traces, burrows, footprints, or coprolites (known as trace fossils). Following are some of the most common forms of fossilization.

- ***Molds and casts.*** Calcareous shells may dissolve, leaving a cavity in a rock that is later filled with sediment or minerals, forming a mold and cast of the original organism. Only the general shape and form of the original organism is left.
- ***Mineralization, replacement, or petrification.*** Original shell, bone, or wood may be infiltrated or totally replaced by a mineral that seeps into pores via mineral-laden groundwater. When this happens, scientists can observe even tiny details of cell structure in bones and the cells and growth rings in petrified wood.
- ***Re-crystallization.*** Shells may re-crystallize, leaving original shell material but in a different mineral form. For instance, many shells are formed from calcium or aragonite, which changes to calcite during fossilization.
- ***Carbonization.*** Between layers of finely bedded shale, original organic material may be compressed and distilled away, leaving only a thin film of carbon on a bedding plane, as often happens with leaves and insects that fossilize.
- ***Original remains.*** Sometimes, animal or plant remains may undergo little to no alteration at all. Such is often the case with fossils such as teeth that are resistant to decay. Or an animal like an insect may be captured in sap, which hardens into amber, creating a natural time capsule that preserves the original organic material. (Scientists have been able to extract bits of ancient DNA from such insects!) In Siberia, creatures such as woolly mammoths have been found locked in ice that has remained frozen since the Ice Ages.

Making a Fossil Using Clay and Plaster.

This activity simulates how fossils in the forms of molds and casts are created.

Materials.

- Plaster of Paris
- Jug of water
- Modeling clay
- Vegetable oil
- Paintbrush (1-inch wide)
- Paper cups
- Dowels or sticks
- Small cardboard containers
- Shells, leaves, or fossil models
- Paper towels
- Masking tape
- Pen or marker
- Roll of large paper/newspapers
- (optional) paints and paint brushes

Procedure.

1. This can be a messy procedure, so start by protecting your tabletop or other work surface by spreading out a roll of paper, newspaper, or some sort of drop cloth.
2. Place a chunk of modeling clay into the bottom of a small cardboard container (the cut-off bottoms of individual-serving milk cartons, paper cups, or Pringles potato chip cans work well) and press into a flat, smooth surface.
3. With your 1-inch wide paintbrush, brush a light coating of vegetable oil across the surface of the clay. This is to make it easy to remove your fossil model and, later, the plaster cast. Otherwise, the clay will stick.
4. Have kids select the fossil they wish to make. Use real leaves or seashells or plastic models of fossils. Such models often may be found in museum gift shops. Ward's Natural Science (www.wardsci.com) also sells a set of plastic fossil models. Ones that seem to be most popular with kids are trilobites, ammonites, and shark teeth.
5. Press the fossil model or seashell into the clay and then remove it to create a mold.
6. Mix and stir plaster and water in a paper cup with a dowel or stick to the consistency of a thick milkshake. Pour it into the mold created in the clay. Use the dowel to get all the plaster out, and if you're making a number of fossils and will need to re-use the dowel, wipe it clean right away with paper towels before the plaster hardens on it.
7. Gently tap the bottom of your container with the clay and plaster several times against the tabletop to ensure that the plaster completely fills the mold and to remove any air bubbles in the plaster.
8. It takes about 15 to 20 minutes for the plaster to dry enough to complete this project, and if you're working with a lot of kids, it's easy to mix up which fossil belongs to whom. Have kids write their names on small strips of masking tape with pens or markers and affix them to their fossil containers. Set all the containers aside to dry. During this drying period, you should have another activity; otherwise, you'll hear "Is my fossil ready yet?" about 200 times. This is a nice activity to do prior to a meeting; once the meeting is over, before everyone goes home, you can return to the fossils. Or, after setting everything aside to dry, you might show a video about fossils and cap it off by having everyone unveil and share their newly minted fossils.
9. Once the plaster has dried, tear the cardboard container and peal the cardboard away, leaving a layer of clay attached to a layer of plaster. This gives you a chance to talk about layers of sediment and to show kids how fossil-bearing sediments usually (but not always) form in discrete layers.
10. Peal the clay away, and your kids will find a cool fossil in their slab of plaster. Many kids then write their names on the backs of their fossil slab.
11. Optional. Have kids paint their fossils. Glossy or flat enamel paints (the kinds used with plastic model airplanes and cars) work well in shades of black, gray, brown, or beige. Craft stores often carry textured "sand" paints, so kids can paint the surface around the fossil to resemble a real matrix. I've also found a pearly coating at one craft store. I painted it over an ammonite cast that I had painted a brassy brown. The pearl coating gave a glossy, iridescent sheen just like real mother-of-pearl. Experiment with different sorts of paints and coatings like these.

I've also been told about a fossil-making activity that calls for mixing together one cup of used coffee grounds, one-half cup of cold coffee, one cup of flour, and one-half cup of salt in a mixing bowl. Knead this into a dough, flatten it on a sheet of waxed paper, and cut out small squares or circles. Press objects such as scallop, snail, or clam shells into the dough, remove the object, and either allow the dough to harden for a day or two or bake it briefly in an oven. The resulting items have the look and feel of a real fossil in matrix. Or, for yet another, simpler process to make fossils using just self-hardening clay, see the back-up page for 10.4.b) Sedimentary rocks: Making fossils.

Note: *You can use any of the activities described above to help kids satisfy requirements toward earning both their Fossils and Earth Processes (Activity 10.4.b) badges simultaneously.*

Making Cut-and-Fold Models of Fossils Using Cardstock.

The following website has links to a number of really neat masters you can download and print for free to then copy on paper or cardstock for kids to craft cut-and-fold 3D models of fossils: http://www.conservation.ca.gov/cgs/information/Pages/3d_papermodels.aspx

Making Tri-lo-"Bites" and Other Delectable Fossil Treats.

Even more fun than making plaster fossils—especially for younger kids—is making Tril-o-"Bites." Dennis Gertenbach of the Flatirons Mineral Club in Colorado sent this activity. Haul out your grandma's Christmas cookie recipe, gather kids in the kitchen, and work with them to fashion, bake, and decorate cookies with frosting in the forms of trilobites, ammonites, star fish, dinosaurs, and other fossil creatures. In the process, they'll be learning about the names and shapes of different fossils in a way that should leave a good taste in their mouths when everyone gets to eat their fossil creations!

The Kentucky Geological Survey website has a Trilobite Cookie recipe as well as recipes for "Prehistoric Appetizers". Go to www.uky.edu/KGS/education/trilobitecookies2.htm and www.uky.edu/KGS/education/cookbook.htm. Those appetizers include Ammonites-in-a-Blanket, Cephalopods-in-a-Blanket, and Cephalopod Celery. Yummy!

Making Fossil Bones from Sponges.

Cut sponges into the shapes of bones and set them in a pan or tray. Pour a saturated solution of hot water and Epsom salts into the pan and over your sponges then set the pan aside for a week or so until all the water has been absorbed into the sponges or has evaporated and the sponges have dried. You should end up with stiff sponges with pores holding crystals of Epsom salts, just as petrified dinosaur bones turn rock-hard from the minerals that flowed through their cells.

Making Artificial Amber with Insects.

Amber is resin from trees that has hardened over the ages. Basically, it's fossilized tree sap. It is often sought after by lapidary artists to be crafted into lightweight jewelry with beautiful golden transparency. In fact, amber is considered an "organic" gemstone. It is

also sought after by fossil collectors because that same sap that results in amber also sometimes trapped insects, bits of leaves, or other critters when it was still gooey and sticky. These make for some of the best fossils around in that every detail of the insect is preserved in three dimensions, right down to antennae and the tiniest hairs on an insect leg. It's literally like a window into ancient life!

Help your kids make artificial amber using dead and dried insects and polyester or epoxy casting resins. Such resins usually come in a kit along with a hardener. Look in craft stores like Michael's or Ben Franklin. I've also run across instructions on a website called RockHoundBlog for making amber using clear nail polish colored with yellow food coloring (along with a drop of red): http://rockhoundblog.com/regular-postings/how-to-make-amber/

While the activity above results in some great paperweights, another activity results in great snacks! The "ehow" website offers recipes for creating edible "jello amber" and "amber brittle," both embedded with gummy insects. For the full recipes, see http://www.ehow.com/how_8347295_make-amber-fossils.html

Excavating a Fossil.

This activity gives kids a fun way to learn about the basics of fossil excavation without leaving home! Mix together a scant quarter cup of plaster of Paris, a generous cup of coarse-grained washed plaster sand (available in bags at hardware stores) that has been thoroughly dried, and, optionally, a bit of diatomite (available with swimming pool supplies in hardware stores). Add water to this mixture to the consistency of pancake batter. You may need to experiment a bit to get the right proportions and consistency.

Pour the wet matrix you've just made into three fist-sized containers or cups. Set a fossil into this matrix in each container. Lightly spraying the fossil with a vegetable oil like Pam will make it easier to chip out. You might use a real fossil (a crinoid stem fragment, a brachiopod, a shark tooth, etc.) or a small plastic dinosaur skull or skeleton from a toy store. (I've obtained some at our local 99¢ Store.) Pour more matrix to cover the fossil. Keep a tip of the fossil emerging from the top so kids will know where to begin their excavation.

Once the matrix has hardened, it can be removed from the container to dry thoroughly. Make one for each kid in your group, and give everyone a nail to "excavate" fossil treasures. You can also use wooden skewers as excavating tools. Because bits of matrix may go flying as kids chip away, eye protection is recommended. Once all fossils have been chipped out into the open, have your junior paleontologists learn about the fossil that each has just excavated.

In addition to mixing up your own chunks of sedimentary rocks for excavation, you can also find pre-made kits containing blocks, digging tools, and a brush. Look for these in museum gift shops, stores catering to teachers, and similar venues.

Back-up page 3.3: The forms of life.

The AFMS publishes the *AFMS Fossil List*, which represents the approved reference list of classifications and common names of fossils used in judging competitive exhibits of fossil collections. This highly detailed list serves as an invaluable reference tool. You can receive information about obtaining a copy by contacting the AFMS central office at the following email address: central_office@amfed.org. Or you can download a copy yourself from http://www.amfed.org/rules/rules.htm. Once in the site, click on "AFMS Approved Reference List of Classifications and Common Names for Fossils," and then make sure you have a good supply of paper in your printer because the document is over 20 pages long.

In addition to the *AFMS Fossil List*, you'll find classifications provided in the many fossil guidebooks listed above on the first back-up page for the Fossils badge. And you might check out the website "Yup…Rocks" (www.yuprocks.com), which features a photo gallery of fossils from the major phyla.

How much detailed knowledge kids should have of the different forms of life will vary with the ages of the kids with whom you're working. For younger kids, it's enough that they learn to use common names and to distinguish among, say, clams, starfishes, sponges, etc. The older the kids, the more detail they should be expected to learn, moving from common names to scientific nomenclature, using Bivalvia (previously called Pelecypoda), Asteroidea, Porifera, and so on.

On the next page, you'll find a general listing of the major fossil taxa most often included in the collections of amateur fossil hunters.

Representative Phyla of the Animal Kingdom

Invertebrates:

Porifera (sponges)
- Representative classes: Calcarea, Demospongia, Hexactinellida

Cnidaria (corals, jellyfish, sea pens, sea anemone)
- Representative classes: Protomedusae (jellyfish), Hydrozoa, Anthozoa (corals)

Bryozoa (bryozoans, or "moss animals")
- Representative classes: Stenolaemata, Gymnolaemata

Brachiopoda (brachiopods)
- Representative classes: Inarticulata, Articulata

Mollusca (mollusks)
- Representative classes: Gastropoda (snails), Bivalvia or Pelecypoda (clams, oysters, scallops), Cephalopoda (cephalopods: ammonites, nautiloids, squid, octopi), Scaphopoda (scaphopods)

Annelida (worms)
- Representative classes: Polychaeta (marine worms), Oligochaeta (earthworms)

Arthropoda (arthropods)
- Representative classes: Trilobita (trilobites), Ostracoda (ostracods), Insecta (insects), Crustacea (crabs, shrimps, lobsters), Cirripedia (barnacles)

Echinodermata (echinoderms)
- Representative classes: Blastoidea, Crinoidea, Asteroidea (starfish), Ophiuroidea (brittle stars), Echinoidea (sea urchins, sand dollars), Holothuroidea (sea cucumbers)

Vertebrates:

Chordata (vertebrates)
- Representative Classes:
- Chondrichthyes (cartilagenous fishes: sharks, skates, rays, guitarfish)
- Osteichthyes (bony fishes)
- Teleosteri (ray-finned fishes)
- Amphibia (amphibians)
- Reptilia (reptiles: lizards, turtles, crocodiles, dinosaurs, flying reptiles, marine reptiles)
- Aves (birds)
- Mammalia (mammals)

Representative Classes and Orders of the Plant Kingdom

Sphenopsida (horsetails)
Filicopsida (ferns, tree ferns)
Pteridospermales (seed ferns)
Cycadales (cycads)
Glossopteridales (glossoperid)
Ginkgoales (ginkgoes)
Cordaitales (cordaites)
Coniferales (conifers: pines, spruce, etc.)
Magnoliopsida (dicotyledon angiosperms, or flowering plants)
Liliosda (monocotyledon angiosperms, or flowering plants)

Back-up page 3.4: Collecting fossils.

Back-up pages for Badge 5 on Collecting provide information on building a collection. You should refer to those back-up pages for reference in assisting kids in satisfying Activity 3.4. For instance, there you'll find information about how to organize a catalog or logbook for an entire collection, how to create labels for individual specimens within a collection, and how to store a collection.

Note: *Kids can use this activity to satisfy requirements toward earning the Collecting badge simultaneously (Activity 5.1).*

Back-up page 3.5: A fossil-collecting field trip.

Back-up pages for Badge 8 on Field Trips provide information on organizing and taking a field trip. You should refer to those back-up pages for reference in assisting kids in satisfying Activity 3.5. For instance, there you'll find the AFMS Code of Ethics, general rules of field trip etiquette, and suggestions on organizing and conducting a field trip and the tools and supplies you'll need.

Note: *Kids can use this activity toward satisfying requirements for the Field Trips badge simultaneously (Activity 8.3).*

Back-up page 3.6: Your state fossil.

A terrific book to share with your kids is Stephen Brusatte's *Stately Fossils: A Comprehensive Look at the State Fossils and Other Official Fossils* (2006). Brusatte provides background about each fossil and how it came to be the designated state fossil.

Alabama – *Basilosaurus cetoides* (Eocene whale)
Alaska – *Mammuthus primigenius* (Pleistocene woolly mammoth)
Arizona – *Araucarioxylon arizsonicum* (Triassic petrified wood)
Arkansas – none
California – *Smilodon (californicus) fatalis* (Pleistocene saber tooth cat)
Colorado – *Stegosaurus stenops* (Jurassic dino)
Connecticut – *Eubrontes giganteus* (Triassic/Jurassic dinosaur footprint)
Delaware – *Belemnitella americana* (Cretaceous cephalopod, or belemnite)
District of Columbia – *Capitalsaurus* (dinosaur)
Florida – *Eupatagus antillarum* (Eocene heart urchin)
Georgia – Tertiary Shark Teeth
Hawaii – none
Idaho – *Equus simplicidens* (the "Hagerman horse" from the Pliocene Epoch)
Illinois – *Tullimonstrum gregarium* (Pennsylvanian "Tully Monster")
Indiana – none
Iowa – none
Kansas – none
Kentucky – Paleozoic Brachiopod
Louisiana – *Palmoxylon* (Oligocene petrified palm wood)
Maine – *Pertica quadrifaria* (Devonian plant)
Maryland – *Ecphora gardnerae* (Miocene marine gastropod) + a state dinosaur, *Astrodon johnstoni* (Cretaceous dinosaur)
Massachusetts – Jurassic Dinosaur Tracks
Michigan – *Mammut americanum* (Pleistocene mastodon); also, the state rock is a fossil, *Hexagonaria percarinata* (a Devonian coral called "Petoskey Stone")
Minnesota – *Castoroides ohioensis* (Pleistocene giant beaver; this is the "unofficial" state fossil)
Mississippi – *Basilosaurus* and *Zygorhiza kochii* (Eocene whales)
Missouri – *Delocrinus missouriensis* (Pennsylvanian crinoid) + a state dinosaur, *Hypsibema missouriensis*
Montana – *Maiasaurus peeblesorum* (Cretaceous dinosaur)
Nebraska – Pleistocene Mammoth
Nevada – *Shonisauris ichthyosaurus* (Triassic ichthyosaur, a marine reptile)
New Hampshire – none
New Jersey – *Hadrosaurus foulkii* (Cretaceous dinosaur)
New Mexico – *Coelophysis* (Triassic dinosaur)
New York – *Eurypterus remipes* (Silurian sea scorpion)
North Carolina – none
North Dakota – Teredo Petrified Wood (Paleocene wood bored by shipworms)
Ohio – *Isotelus* (Ordovician trilobite)
Oklahoma – *Saurophaganax maximus* (Jurassic dinosaur)
Oregon – *Metasequoia* (Eocene dawn redwood)
Pennsylvania – *Phacops rana* (Devonian trilobite)
Rhode Island – none
South Carolina – none
South Dakota – *Tricerotops prorsus* (Cretaceous dinosaur)
Tennessee – *Pterotrigonia thoracica* (Cretaceous bivalve)
Texas – *Pleurocoelus* (Cretaceous dinosaur)
Utah – *Allosaurus fragilis* (Jurassic dinosaur)
Vermont – *Delphinapterus leucas* (Pleistocene beluga whale)
Virginia – *Chesapecten jeffersonius* (Pliocene pecten, or scallop)
Washington – *Mammuthus columbi* (Pleistocene Columbian mammoth)
West Virginia – none (but the state gem is a Mississippian fossil coral, *Lithostrotionella*)
Wisconsin – *Calymene celebra* (Silurian trilobite)
Wyoming – *Knightia* (Eocene herring) + a state dinosaur, *Tricerotops* (Cretaceous dinosaur)

Note: *Kids who write a paper or give an oral report for this activity can also use it to satisfy requirements toward earning the Communication badge (Activities 7.1 and 7.2).*

Back-up page 3.7: Dinosaurs.

Dinosaurs exert an almost universal pull on kids. It's as if dinosaur fascination is built into kid DNA! Younger kids especially love reading stories about dinos, playing with dinosaur toys, and learning their long, complicated scientific names. Here are a few activity suggestions revolving around dinosaurs to help you capitalize on that fascination:

- Test dinosaur identification skills with flashcard games or plastic models. Dinosaur cards are commercially available, or you can make your own by cutting pictures of dinosaurs from books, magazines, or web sites. If using plastic models, you can reward kids who come up with the right name by giving them the model—one model per child in your group. You can also give kids pages from a dinosaur coloring book, with each child coloring a different dinosaur and sharing—and naming—the results with the group. And for yet another activity for testing dino-ID skills, construct crossword puzzles with names of dinosaurs.

- Use "dino eggs" to test dinosaur identification skills. You can make eggs by inflating and coating balloons with paper mache made from strips of newspaper soaked in water and flour. Once the paper mache has dried, use a pin to pop the balloon inside, cut a slit, insert a plastic dinosaur model, then paper mache over the slit. Once dry, paint the egg. Or, for a simpler process, just buy big plastic eggs that show up at stores prior to Easter that can be opened to insert candy. Instead of candy, insert small dinosaur models of different species. Give each junior member an egg to crack open and have them identify the dinosaur inside.

- Draw and color dinosaur murals or timelines on a long sheet of paper, incorporating dinosaur stickers. Sheets of dinosaur stickers can be found in party or gift-wrapping sections of stores, in craft stores, bookstores, etc.

- Create dino-dioramas with models in shoe boxes. Talk with your kids about which dinosaurs in the diorama are plant eaters versus meat eaters and who's hunting whom.

- Make dinosaur masks on cardboard sheets using templates available from web sites or from books such as Shaffer's *Cut & Make Dinosaur Masks* or Smith's *Dinosaur Punch-Out Masks.* You can also make 3-D masks by coating large inflated balloons with papier-mâché and building out snouts or using grocery bags, cardboard, glue, colorful markers, and other readily available materials.

- Make dinosaur hand puppets by following the directions at www.bgs.ac.uk. Select Discovering Geology, then Time, and finally Prehistoric Puppets and Models, and you'll be led to a site offering cut-out models for crafting Pterosaur, Styracosaur, and T. rex puppet heads, as well as orthoceras nautiloids and trilobites. Fun!

- Craft cut-and-fold 3D models of dinosaurs using free templates from this website: http://www.conservation.ca.gov/cgs/information/Pages/3d_papermodels.aspx.

- Assemble dinosaur skeletons from chicken bones (see Chris McGowan's books, *Make Your Own Dinosaur out of Chicken Bones* and *T-Rex To Go: Build Your Own from Chicken Bones*). Commercial kits are available from places like Edmunds Scientific for "excavating" bones and/or building skeleton models with wooden or plastic bones. A fun group activity for assembling a 6-foot dino skeleton involves cutting large bones out of cardboard and hiding them around a room. Then hold a scavenger hunt. Once all bones have been found, assemble them with brass fasteners.

- Hold a fact-or-fiction quiz contest game. A site devoted to "Dinosaurs: Facts & Fiction" is on the USGS web site: http://pubs.usgs.gov/gip/dinosaurs/ There's also the book by Scotchmoor, et al., *Dinosaurs: The Science behind the Stories*, 2002.

- Make collections of fossils from the age of dinosaurs. Some parts of the U.S., like Texas, the Dakotas, the Rocky Mountain states, and the West in general, abound in marine and land fossils from the Mesozoic Era, and localities with Cretaceous marine fossils are common on the East Coast and Southeast.

- Make dinosaur footprint molds and casts with clay and plaster and the feet of plastic dinosaur models.

- Simulate the sounds of dinosaurs! Hadrosaurs had large, hollow crests on their heads. Paleontologists believe they used these to "honk" to one another. Using two 3- or 4-foot lengths of PVC pipe joined by a U-shaped connection, you can craft a simulated hadrosaur crest. With a big breath, blast into it as you would with a tuba, blowing air through pursed lips, and the honk of a hadrosaur will fill the air, some 65 million years after the last hadrosaur honk blasted across the land.

- Visit a museum that has dinosaur skeletons or go on a dinosaur-related field trip to a place like a dinosaur track-way park. Daniel and Susan Cohen have written a handy book whose title says it all: *Where to Find Dinosaurs Today* (1992). It's a state-by-state listing with descriptions of museums with dinosaur fossils.

- Send kids on a "Dino Scavenger Hunt." At a monthly meeting, ask them to come to next month's meeting with a list of places they saw dinosaurs. For instance, I've seen them on cereal boxes at the grocery store, on TV cartoons, on lunch boxes, on T-shirts, on gift-wrapping paper, and in the toy store. Did dinosaurs really go extinct 65 million years ago? Hard to tell, given that they still seem to surround us!

- You can find dinosaur activities, quizzes, and more on museum web sites. For instance, enter "Dinosaur Dig" into the search box of the San Diego Natural History Museum web site, www.sdnhm.org. Check for similar sections on the web sites of major museums around the country, such as the Chicago Field Museum, American Museum of Natural History in New York City, Natural History Museum of Los Angeles County, Smithsonian Natural History Museum in Washington, DC, etc.

- A web site offering things like dinosaur trading cards, colorable posters, and craft projects is "Dino Dan," at www.nickjr.com/dino-dan. (We were alerted to this neat web site by Daniel Jones of the Midland Gem & Mineral Society of Texas.)

- To access many dinosaur facts, games, activities, printables, coloring pages, and more, go to "The Teacher's Guide" at http://theteachersguide.com, and enter "Dinosaurs" into the search box.

- In addition to the websites already noted above, one book offers one-stop shopping for all sorts of dino-related sites: R.L. Jones and Kathryn Gabriel's *Dinosaurs On-Line: A Guide to the Best Dinosaur Sites on the Internet* (2000).

- One book with all sorts of dinosaur facts and trivia is Rachel Firth's *Dinosaurs* (2001), in the Usborne Discovery Internet-Linked Series. It offers links to recommended web sites to extend learning beyond the pages of the printed book via the Usborne Quicklinks Website at www.usborne-quicklinks.com, where you enter the keywords "discovery dinosaurs." The featured web sites offer further information, animations, games, activities, and more, including pictures kids can download and use in reports.

In addition to these activities, there's no end of dinosaur activity books geared to every age level. One example is Janice VanCleave's *Dinosaurs for Every Kid.* Another is *Mryna Martin's Dinosaurs: Hands-on Activities*. Myrna Martin began a home-based business called Ring of Fire Science Company in Oregon (www.RingofFireScience.com). Inspired by the eruption of Mount Saint Helens 90 miles from her home, she crafted a set of lesson plans on volcanoes that grew into a whole "Hands-on Science" series. These include her dinosaurs book, which is nicely illustrated with easy-to-follow instructions for 15 fun activities related to dinosaurs.

Check Amazon.com, the kids' sections of bookstores, teacher supply stores, and the web. Just type "dinosaur" into a search engine like Google, and thousands of possibilities spring up! Pick one or more to do a dinosaur activity with your club's kids—and thank Mitty Scarpato (of the Conejo Gem and Mineral Club in California) for suggesting that we include Dinosaur activities in the FRA Badge Program.

Back-up page 3.8: Fossil and dinosaur names.

Fossils, including dinosaurs, often have long names that seem impossible to pronounce but that, somehow, kids seem to master with ease. These names may look strange to English readers because they are often put into Latin or Greek forms.

Teach how dinosaurs and other fossils were named by exploring Latin and Greek root words. Fossils are sometimes given Greek or Latin names for where the fossil was found. For instance, the dinosaur *Utahraptor*, stands for "Utah predator" for a meat-eating dinosaur that was discovered in the state of Utah. Or a fossil is sometimes named in honor of a significant person. For instance, *Darwinius masillae* is a fossil primate named for a Latinized version Charles Darwin as well as for the Latinized place it was discovered: Messel, Germany. Or the fossil may be described—in Latin or Greek—for its characteristics. Thus, *Tyrannosaurus rex* stands for "king of the tyrant lizards" and *Titanosaurus*—the largest of all dinosaurs—stands for the Titans of Greek mythology.

Two websites contain good information on dinosaur names, in particular:

- www.Kidsdigdinos.com/dinosaurnames.htm
- www.bing/images/search?q=%22dinosaur+names*%22&FORM=HDSC2

Myrna Martin's book *Dinosaurs: Hands-on Activities* has a nice table on page 9 showing root words from Latin or Greek and their meanings in English, such as *alto* (high), *cephalo* (head), *crypto* (hidden), *echino* (spiny), *nano* (dwarf), *rex* (king), etc.

As one activity, suppose your junior members discover an entirely new dinosaur and get to name it after your society. For instance, my society's juniors might name it *Venturasaurus* ("Ventura lizard") after the Ventura Gem & Mineral Society. In fact, there already exists a fossil sand dollar called *Dendraster venturaensis*! What would your club's new dinosaur be named?

As an alternative activity, challenge kids to create a new dinosaur or other fossil creature and draw pictures of this new animal or plant. Then have them name it and explain why they gave it that name.

Or, instead of creating and naming an entirely new fossil, ask kids to select a fossil and explore its scientific name. What is the origin of that name? Has it been translated into Greek or Latin? Why was the fossil given that name? Perhaps assign them to write an article about the name for your society newsletter or to give a report at a club meeting.

As a reward, you might give each child a piece of genuine dinosaur bone or a sample of whatever fossil you were using for a naming exercise (a trilobite, crinoid stem, brachiopod, sea urchin, coral, etc.).

Note: *Kids who prepare an oral or written report can use this activity toward satisfying requirements for the Communication badge simultaneously (Activities 7.1 and 7.2).*