Time and Fossils Introduction

Scientists have evidence that the planet Earth formed approximately 4.6 billion years ago. Human history represents an extremely tiny portion of the Earth's total history. Scientists have used fossil evidence and the study of geologic formations to try to understand the changes in the Earth and its life forms over the course of the planet's history.

The study of fossils can provide us with important knowledge about the Earth's past. Dinosaur bones, for example, can give scientists such information as the animal's size, shape, and feeding habits. Fossil plants provide clues about the environment that existed in ancient times. For example, coal found in Antarctica suggests that the climate was much different in the past, since coal forms only from swamps. The Theory of Evolution, which says life forms gradually changed throughout the history of the Earth, is supported by fossil and other evidence.

The National Science Education Standards (1996), state that students in grades K-4 should develop an understanding that:

- Fossils provide evidence about the plants and animals that lived long ago and the nature of the environment at that time.

Students in grades 5-8 should develop an understanding that:

- Fossils provide important evidence of how life and environmental conditions have changed.

- Extinction of a species occurs when the environment changes and the adaptive characteristics of a species are insufficient to allow its survival. Fossils indicate that many organisms that lived long ago are extinct. Extinction of species is common; most of the species that have lived on the Earth no longer exist.

Introducción al Tiempo y a los Fósiles

Los científicos tienen la evidencia de que el planeta Tierra se formó hace aproximadamente 4.6 billones de años. La historia humana representa una porción extremadamente pequeña de la historia total de la tierra. Los científicos han utilizado evidencia de fósiles y el estudio de formaciones geológicas para tratar de entender los cambios en la tierra y sus formas de vida durante la historia del planeta.

El estudio de fósiles puede proveernos con importante conocimiento sobre el pasado de la Tierra. Los huesos de dinosaurio, por ejemplo, pueden dar a los científicos información tal como su tamaño, su forma, y hábitos alimenticios. Los fósiles de las plantas proveen de datos sobre las condiciones que existían en tiempos antíguos. Por ejemplo, el carbón encontrado en Antártida sugiere que el clima era muy diferente en el pasado, debido a que ese carbón se formaba solo en pantanos. La Teoría de la Evolución, que habla cambios graduales de vida a través de la historia de la Tierra, se apoya sobre la evidencia de los fósiles.

Las Normas de la Educación Nacional de Ciencia (1996) [National Science Education Standards (1996)], estatuyen que los estudiantes en los grados K-4 deberían desarrollar el entendimiento de que:

- Los fósiles proveen evidencia sobre las plantas y animales que vivieron hace mucho tiempo y la naturaleza del medio ambiente de ese tiempo.

Los estudiantes en los grados 5-8 deberían desarrollar el entendimiento de que:

- Los fósiles proveen importante evidencia de cómo ha cambiado la vida y las condiciones del medio ambiente.

- La extinción de las especies sucede cuando los cambios del medio ambiente y las características de adaptación de las especies son insuficientes para permitir su sobrevivencia. Los fósiles indican que muchos organismos que vivieron hace mucho tiempo están extintos. La extinción de las especies es común; la mayor parte de las especies que han vivido en la Tierra ya no existen.

HOW MUCH IS A MILLION?

Grades		
4-8	individuals/ pairs	45 min.

Description: Students will gather a million of something and demonstrate to others how they determined they do, in fact, have a million.

Materials for Each Group or Individual:
an assortment of items to be counted (see Procedure, Step 1)
an assortment of measuring devices such as cups, balances, beakers, etc.

Procedure:

1. As a class, generate a list of items of which you think you could conveniently and inexpensively get a million. Arrange with students to have these materials brought in to class. Examples could include salt, sugar, colored sprinkles, rice, popcorn, aquarium gravel, beans, dry cereal.

2. Place all the items to be counted and any measuring devices on tables. Explain to students that they will have to find one million of something and be able to justify their count to the rest of the class.

3. Have students record on paper the technique they used to get a million of the item they chose. Allow students to try counting one-by-one; they will quickly realize that it will take too long.

4. When students have finished, have them demonstrate the technique they used and show how much a million of their item is.

Questions to Ask During the Activity:

1. Why don't you want to count your item one-by-one? [it takes too long]

2. How did you choose the method you used?

3. How long did it take you to determine you had a million?

4. What were the problems you had with your method?

Why It Happens: When looking at geologic time and Earth systems, large numbers are frequently used. It is very difficult to grasp what these large numbers mean and it is too time consuming to rely on counting as the only means of finding out how much of something exists. This activity is intended to give students concrete examples of a million and to discover methods other than counting for measuring a large amount of something.

Some possible methods (other than one-by-one counting) used for determining a million of something might be:

- **sampling volume**—students count a volume (such as a cup) of their item and then determine how many cups of material they have;

- **sampling area**—students measure out a square cm (or other area) with a ruler and count out how many pieces of whatever fit in it. Students then determine how many square cm would represent a million;

- **estimating**—students count out a pile of their material and then make similar piles "by eye" and determine how many they have;

- **weighing**—students weigh a known number of their item and figure out how much 1 million of their item would weigh.

Extensions: Read the book How Much is A Million by David M. Schwartz (New York: Lothrop, Lee & Shepard Books, 1985). This is a simple book with several interesting and entertaining ways of thinking of a million.

References:
Lind, Karen K., ed. Water, Stones, & Fossil Bones. Washington, D.C.: National Science Teachers Association, 1992.

GEOLOGIC TIME LINE

Grades		
4-8	whole class	40 min.

Description: Students will graphically illustrate the concept of geologic time and the location of significant events in earth history.

Materials for Whole Class:
1 roll of string on a roller 100 meters long (kite string w/ a roller handle, works well)
30 index cards
masking tape
meter stick
markers

Procedure:

1. Identify an area approximately 100 meters long to use for the activity- such as a long hallway, playing field or sidewalk. It is important that students be able to see each other all along the string.

2. Prepare the roll of string in advance by marking each meter with a marking pen. Each meter will represent 50 million years; 92 meters will represent 4.6 billion years. Use masking tape to mark intervals of 10 meters representing 500 million year units. For the last 500 million years, label every 50 million years (each meter). Older students could prepare the string as part of the activity.

3. Assign each student an event in geologic history from the Event List at the end of this Activity. Have students write the event on an index card and draw a picture to represent the event or provide pictures for the cards (sample pictures follow this activity).

4. When cards are prepared, have students line up in what they think is the correct chronological order based on their index cards. Once everyone has guessed their spot on the time line, use the information on the Event List to determine where each student should be. Have students write the correct date for their event on their index cards.

5. Tie one end of the pre-marked string to a fixed object and begin rolling out the string. As students find the spot on the time line that matches the date listed on the card, they hold the line at that spot.

6. Once all the students have found their spots on the time line, they tape their index cards to the string.

7. Have students compare their locations in relation to each other.

Variation for a Small Area: You can use the same procedure on a smaller scale by using a string 10 meters long on which each centimeter represents 5 million years (0.1 meters represents 50 million years). On this scale, 9.2 meters will represent 4.6 billion years.

Questions to Ask During the Activity:

1. How many thousands are in a million? [one thousand]

2. How many millions are in a billion? [one thousand]

3. How long is a million seconds? [11.5 days]

4. Which are older, dinosaurs or insects? [insects]

5. Which are younger, amphibians or birds? [birds]

6. Are the Albuquerque volcanoes relatively old or relatively young? [young]

7. Were the Sandia Mountains here when the dinosaurs lived here? [no]

8. **For older students**: Why are most of the events up at the younger end of the time line? [More younger rocks are available for study, so our geologic record is biased towards younger events. Older rocks have had more time to erode and be recycled, destroying the record of older events.]

Why It Happens: The expanse of geologic history is difficult to understand. To humans, the concept of millions and billions of years is beyond our scope of comprehension. The time line illustrates the vastness of geologic time and provides perspective on geologic history.

According to geologic theory, the Earth is approximately 4.6 billion years old. Using stratigraphy, the known age of igneous rocks, and fossils, geologists have been able to place geologic events in chronological order.

Adaptations for Participants with Disabilities:

- For students in wheelchairs, be sure to do the activity in a hallway or other location easily accessible to wheelchairs.
- Visually impaired students can walk the length of the time line to grasp the concept of time.

Extensions: Hang the geologic time line string around the room. Have students add to it as they discover other significant geologic events.

Have students make personal time lines or a time line of human history.

References:

Dinosaur Classification, Teacher's Guide. Hudson, New Hampshire: Delta Education, 1989.

Stein, S. The Evolution Book. New York: Workman Press, 1986.

Time Line Activity
Event List

List of Events:

1. Earth formed .... 4.6 billion years ago
2. First Algae .... 3.5 billion years ago
3. Oldest Rocks in New Mexico .... 2 billion years ago
4. Early Abundant Fossils .... 600 million years ago
5. First Trilobites .... 550 million years ago
6. First Fish .... 480 million years ago
7. First Land Plants .... 420 million years ago
8. First Insects .... 400 million years ago
9. First Sharks .... 350 million years ago
10. First Amphibians .... 370 million years ago
11. Abundant coal swamps in North America
    (source of most of today's coal) .... 300 million years ago
12. Shallow seas covered New Mexico .... 290 million years ago
13. First Reptiles .... 300 million years ago
14. First Conifer Trees .... 230 million years ago
15. First Dinosaurs .... 240 million years ago
16. First Mammals .... 215 million years ago
17. First Birds .... 150 million years ago
18. First Flowering Plants .... 100 million years ago
19. Last Dinosaurs .... 65 million years ago
20. Beginning of Rocky Mountains Formation .... 60 million years ago
21. First Horses .... 40 million years ago
22. First Grasses .... 19 million years ago
23. Modern Rio Grande River Formed .... 8 million years ago
24. Sandia Mountains uplifted .... 5 million years ago
25. First Humans .... 4.5 million years ago
26. Ice Age Begins .... 2 million years ago
27. Mt. Taylor Volcano Erupts .... 2 million years ago
28. Jemez Caldera Volcano Erupts .... 1.5 million years ago
29. Albuquerque Volcanoes .... 190,000 years ago

Note that the list above provides <u>approximate</u> dates.

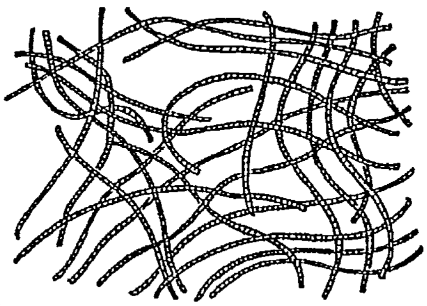
Lista de Eventos en la Línea del Tiempo
- Actividad -

Lista de Eventos:

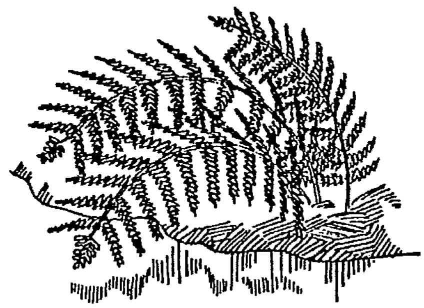
1. Formación de la Tierra .... hace 4.6 billones de años
2. Primeras Algas .... hace 3.5 billones de años
3. Rocas más antíguas en Nuevo México .... hace 2 billones de años
4. Temprana Abundancia de Fósiles .... hace 600 millones de años
5. Primeras Trilobitas .... hace 500 millones de años
6. Primeros Peces .... hace 480 millones de años
7. Primeras Plantas de Tierra .... hace 420 millones de años
8. Primeros Insectos .... hace 400 millones de años
9. Primeros Tiburones .... hace 350 millones de años
10. Primeros Amfibios .... hace 370 millones de años
11. Abundancia de carbón de pantanos en Norteamérica (fuente de la mayor parte del carbón actual) .... hace 300 millones de años
12. Mares bajos cubrían Nuevo México .... hace 290 millones de años
13. Primeros Reptiles .... hace 300 millones de años
14. Primeros Coníferos .... hace 230 millones de años
15. Primeros Dinosaurios .... hace 240 millones de años
16. Primeros Mamíferos .... hace 215 millones de años
17. Primeras Aves .... hace 150 millones de años
18. Primeras plantas de flor .... hace 100 millones de años
19. Últimos Dinosauros .... hace 65 millones de años
20. Comienzo de la formación de las Montañas Rocallosas .... hace 60 millones de años
21. Primeros Caballos .... hace 40 millones de años
22. Primeros Pastos .... hace 19 millones de años
23. Formación del Moderno Río Grande .... hace 8 millones de años
24. Emergen las Montañas Sandía .... hace 5 millones de años
25. Primeros Humanos .... hace 4.5 millones de años
26. Comienzo de la Era de Hielo .... hace 2 millones de años
27. Hace Erupción el Volcán de la Montaña Taylor .... hace 2.0 millones de años
28. Hace Erupción el Volcán de Caldera de Jémez .... hace 1.5 millones de años
29. Volcanes de Albuquerque .... hace 190,000 años

Notar que la anterior lista provee fechas aproximadas

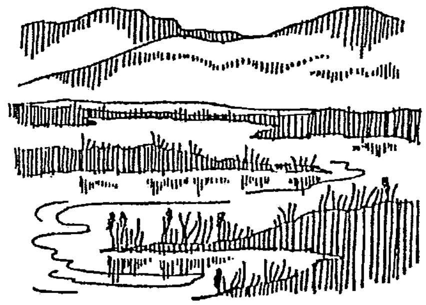
Sample Pictures for Geological Time Line



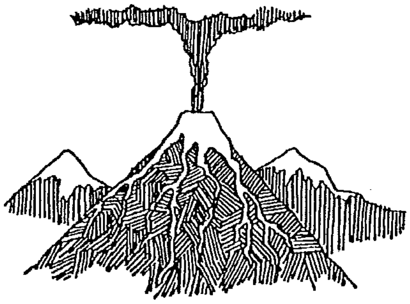
Blue-green algae



Seed fern

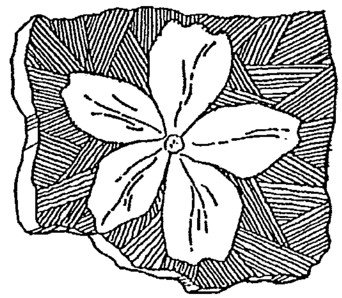


Swamp



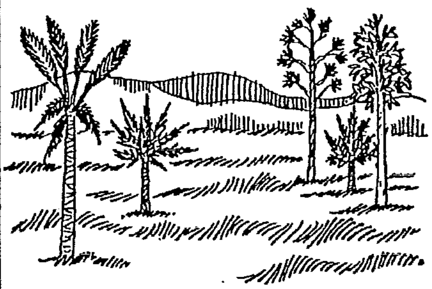
Volcano

Giant sequoia

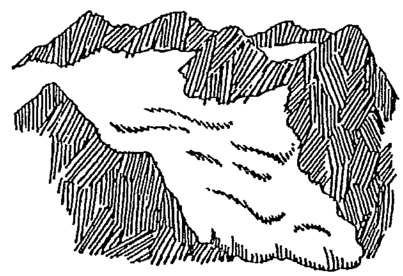


Flower

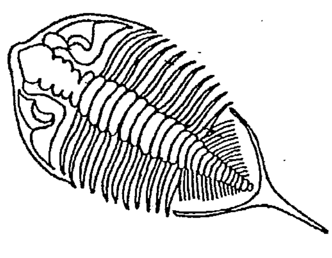
Meteor



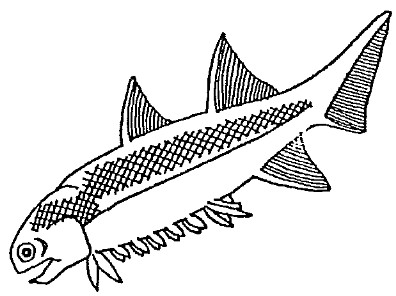
Grassland



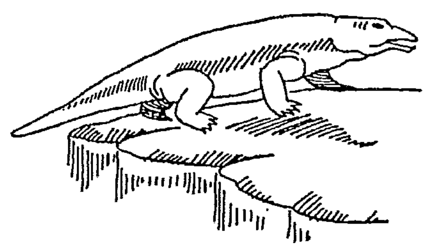
Glacier



Trilobite

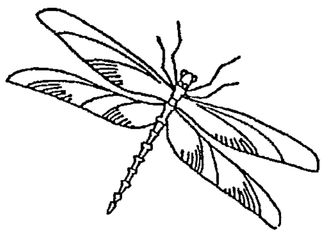


Fish

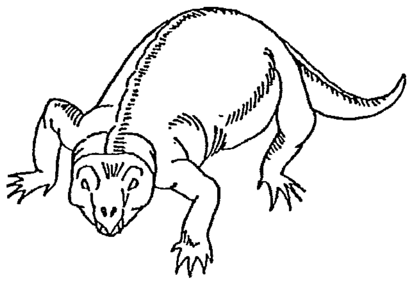


Amphibian

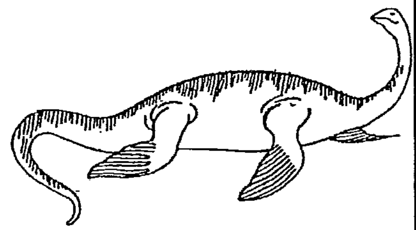
Sample Pictures for Geological Time Line



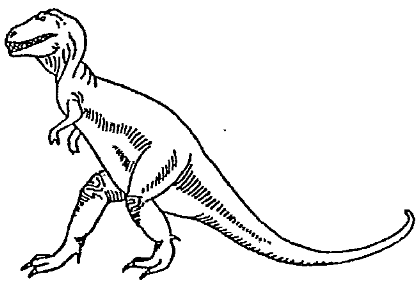
Dragonfly



Early reptile

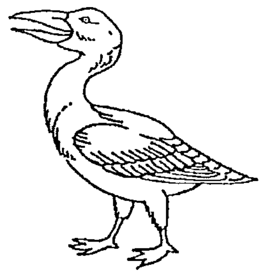


Plesiosaur

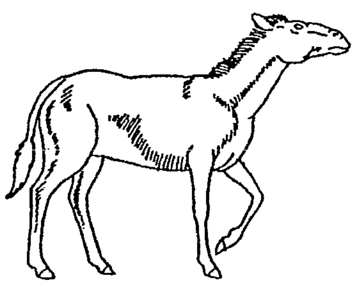


Tyrannosaurus

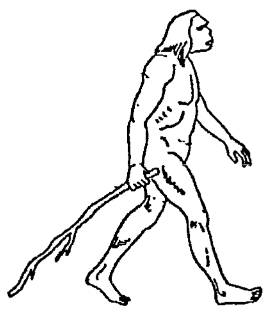
Mammal



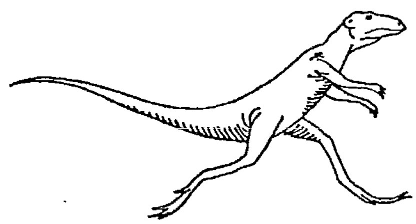
Bird



Early horse

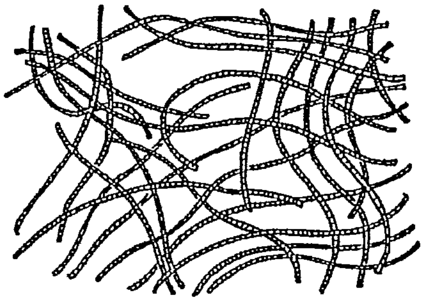


Human



Thecodont

Ejemplos de Ilustraciones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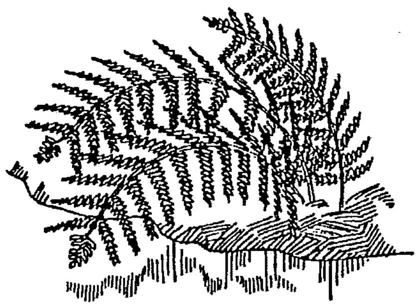
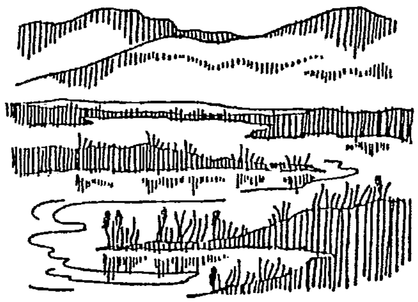

Semilla de Helecho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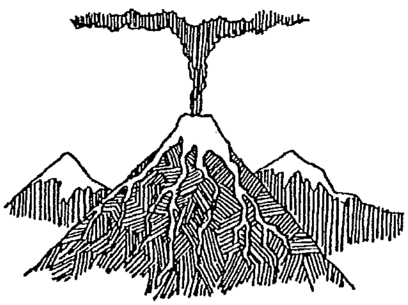
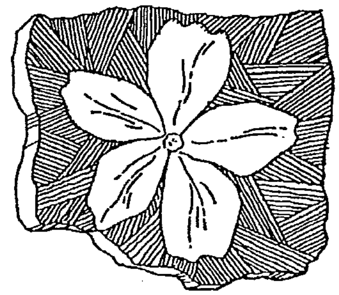
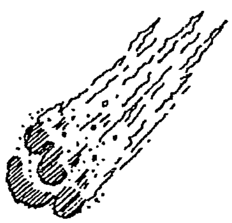
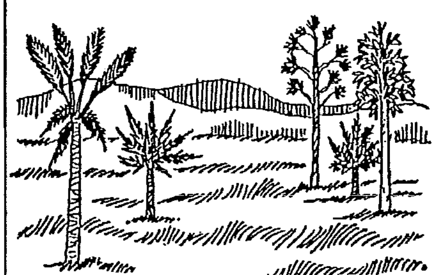
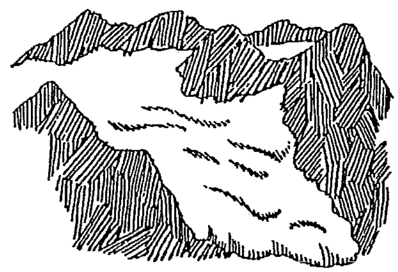

Volcán

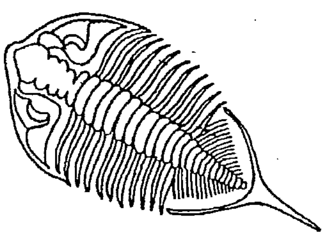

Secoya Gigante

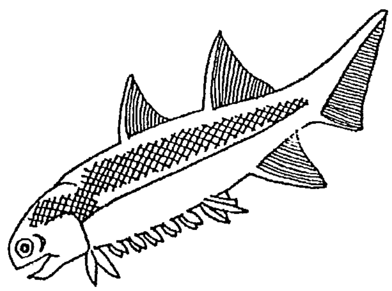

Flor

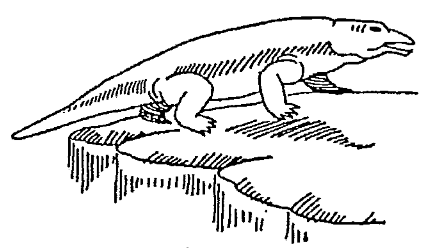

Meteoro


Prado

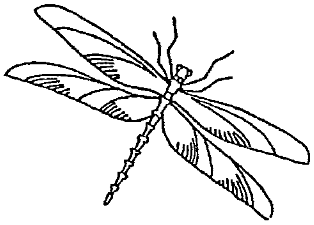

Glaciar


Trilobita

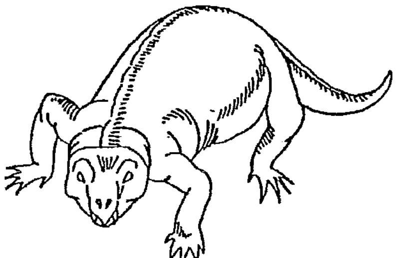

Pez


Amfibio

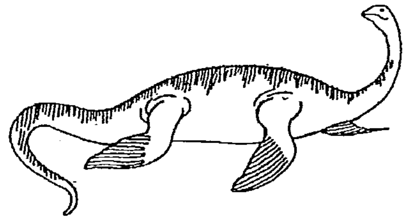
Ejemplos de Ilustraciones



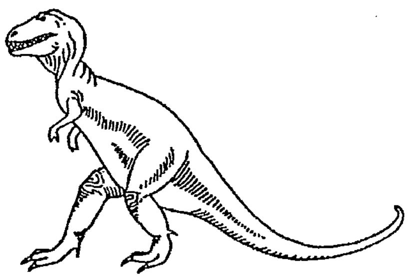
Libélula



Reptil Primitivo

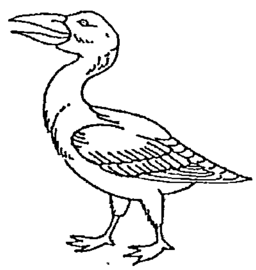


Plesiosaurio

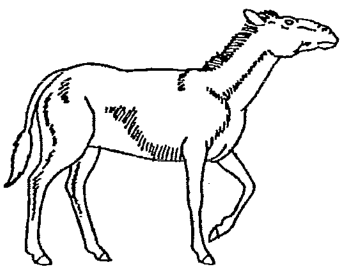


Tiranosaurio

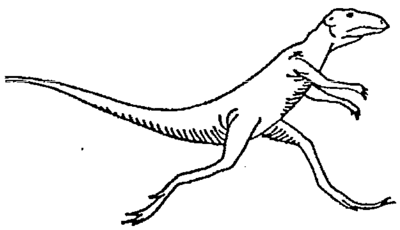
Mamífero



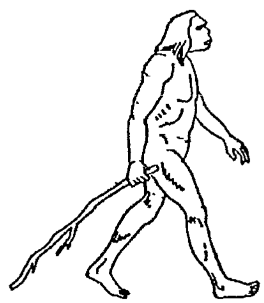
Ave



Caballo Primitivo



Tecodonte



Humano

PROYECTO
FUTURO

TRACKS IN TIME

Grades		
K-4	whole class or 3-4	90-120 min.

Description: Students will observe various shoe and foot prints to infer information about what made the tracks, simulating the work paleontologists have done with fossilized footprints.

Materials for Whole Class:
collection of old footwear (4-5 different shoes)
tempera paint
paint brush
a roll of white butcher paper
30 tag board sheets (8 1/2" x 11")
shallow pan for paint

Safety: Use care in making the footprint tracks, as the paint is very slippery.

Procedure:

Note: The preparation of shoe and footprints (steps 2 and 5) can be done as part of the student activity or by the teacher in advance. Making the prints can get **very** messy if done by several students at once.

1. Make or find a mud puddle. Wearing old shoes, have an adult and a student walk through the mud. As a class, note and record differences in the footprints such as size of print, patterns on the soles of the shoe, depth of footprint, and length of stride. Discuss what causes these differences.

2. Prepare a set of shoe prints. Using old shoes, boots, sandals, etc., paint the bottom of the footwear with tempera paint. Firmly press the shoe onto the tag board, rolling it from toe to heel, leaving a shoe print in paint. Make one print of each shoe for each student group. When completely dry, you can laminate the prints to preserve them.

3. Display each type of shoe print. As a class, discuss what type of shoe might have made the print (sneaker, sandal, adult's, child's, etc.). Show the assortment of shoes you used to make the prints and have students try to match the shoe print to the shoe.

4. Divide the class into groups of 3 or 4. Give each group a set of shoe prints. Have the students classify them into two groups according to one characteristic (e.g., type of shoe, size, left or right shoes, etc). Let each group explain how they sorted the shoe prints. Have students sort the shoe prints again, according to a different characteristic.

5. Prepare some footprint tracks. Roll out a long sheet of butcher paper (15-20 feet). Place a shallow pan of tempera paint at one end of the sheet. Step into the paint in bare feet and then walk along the butcher paper. **NOTE:** ***The paint makes your feet very slippery. You may need assistance in stepping onto the butcher paper***. Make several other strips, but change how you move: try running, hopping, skipping, walking backwards, or waltzing. Wash your feet with warm water and soap as soon as you are done. Once the strips are completely dry, laminate them.

6. Display the butcher paper tracks. Have students discuss what they think you were doing in each case and give reasons for their inferences.

Questions to Ask During the Activity:

1. How does a right foot look different from a left foot? [position of arch and toes]

2. Each time students make an inference about what shoe or action made a print, ask them what clues they saw which led them to that conclusion.

3. How does the length of the stride relate to the size of the person? [when walking, a larger person generally takes a larger step]

Why It Happens: Animal footprints in mud were sometimes preserved as the mud turned to stone. Fossils which provide evidence the animal existed, but don't actually include any part of the animal, are called trace fossils. Footprints found in groups form trackways and can provide scientists with information about whether an animal traveled alone or in groups, how quickly the animal moved and its weight. Fossilized dinosaur tracks can give scientists many clues about the behavior of the creatures when they were alive.

Extensions: Have students investigate the types of tracks left by different animals. One way to do this is to sprinkle flour in a secluded area of the school grounds and place some seeds in the center of the flour. The next day, return to the area to see what animals walked through the flour to get to the seed.

Have students investigate the known stride of some different dinosaurs and use paper cut-outs to recreate a trackway. Have students compare their own stride to that of the dinosaur.

References: Booth, Jerry. The Big Beast Book—Dinosaurs and How They Got That Way. Boston, MA: Little, Brown & Co., 1988.

PROYECTO
FUTURO

MAKING FOSSILS

Grades		
2-6	pairs	2/40 min.

Description: Students will simulate the formation of fossils.

Materials for Each Group:

Part I

1 piece of modeling clay
1-2 small sea shells and/or
  a leaf with deep veins
petroleum jelly
1/2 cup of plaster of paris
1 paper cup
stir stick
water

Part II

1 small commercial sponge
150 ml of salt
250 ml of warm water
mixing bowl
several cups of sand
1 pair of scissors

Materials for Whole Class: fossil samples

Safety: Be sure water is not hot enough to scald students.

Procedure:

1. Have students follow the directions on the Student Activity Sheet to make the mold and cast fossils as well as the petrified fossil. You may want to have students do each part on different days. For younger students, you may want to mix the plaster of paris for them.

2. Pass out sample fossils. Have students discuss how the fossils might have formed.

Questions to Ask During the Activity:

1. How might these processes happen in nature? [see Why It Happens]

2. What is the difference between a mold and a cast? [A mold has the negative impression left by the object, the cast is a recreation of the shape of the object itself.]

Why It Happens: Fossils are the remains or traces of plants or animals that lived more than 10,000 years ago. There are four basic types of fossils: actual remains of organisms, petrified fossils, molds and casts, and prints. Very few of all the different plants and animals that have lived become fossils; usually the organic remains are destroyed by decay.

Actual remains include bones, teeth, shells, and organisms which were trapped in ice, amber or tar. The Amber Fossils teacher demonstration in this unit models the formation of actual remains fossils.

Petrified fossils are the remains of plants and animals that have turned to stone. In permineralization, water breaks up only the organic matter and leaves intact the rest of the original matter. In replacement, water dissolves most or all of the original substance of the plant or animal. In both permineralization and replacement, minerals fill in the small air spaces in bones or shells without changing the original shape of the object. In carbonization, leaves or the soft parts of animals turn to carbon and leave a record of the shape of the plant or animal as a thin form of carbon.

Living things sometimes become buried in mud, clay or other material that hardens around them. Later, the bodies dissolve away, leaving openings within the hard material that are natural molds of the original. Minerals may slowly fill a mold while it lies in the ground, forming a natural cast.

Prints may be molds of thin objects, such as leaves or feathers, or they may be tracks or footprints left by extinct animals. Prints are preserved when the soft mud in which they are made hardens into stone.

Extensions: In Part I, students make a mold of a fossil in clay. Students can make a more permanent mold in plaster of paris. Have them coat a shell with petroleum jelly, place it in a pie pan, and pour the plaster of paris over it. After the plaster has hardened, they can remove the shell and its imprint will remain in the plaster.

Take students on a field trip to collect fossils in the region.

References:
Lind, Karen L., ed. Water, Stones & Fossil Bones. Washington, D.C.: National Science Teachers Association, 1991.

Project Storyline: Science, Primary Geology. California Science Implementation Network, University of California at Irvine, 1993.

Tolman, Marvin N. and James O. Morton. Earth Science Activities for Grades 2-8. West Nyack, NY: Parker Publishing Co., Inc., 1986.

Making Fossils
Student Activity Sheet

Description: You will use two different techniques to simulate how fossils can form.

Materials for Your Group:

Part 1

1 piece of modeling clay
1-2 small sea shells and/or a leaf with deep veins
petroleum jelly
1/2 cup of plaster of paris
1 paper cup
stir stick
water

Part 2

1 small commercial sponge
150 ml of salt
250 ml of warm water
mixing bowl
several cups of sand
1 pair of scissors

Procedure: **Part 1: Making Molds and Casts**

1. Roll out a 1-2 cm thick layer of clay and form a raised "lip" around the rim of the clay.

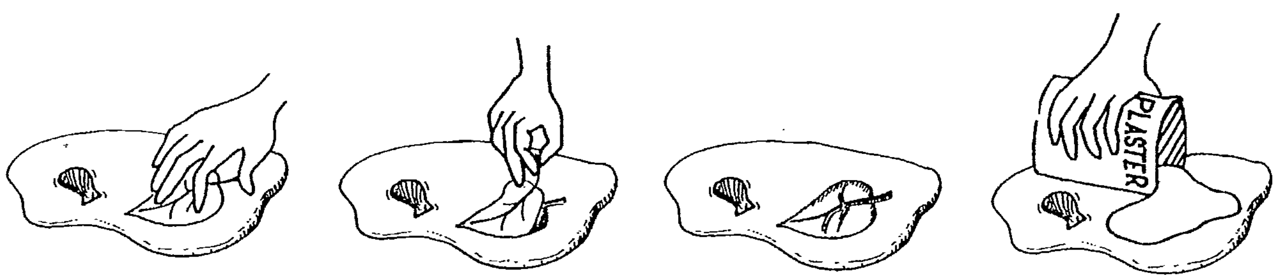
2. Press the shells or a leaf with thick veins into the clay and then remove them carefully. You have formed a mold in the clay.

3. Apply a thin layer of petroleum jelly over the clay surface.

4. Half fill the paper cup with plaster of paris, add water gradually and stir until the mixture becomes thick and creamy.

5. Pour the plaster of paris mixture into the clay imprints and let it harden.

6. After at least one day, remove the clay to see the cast and carefully wipe off any petroleum jelly left on the cast.



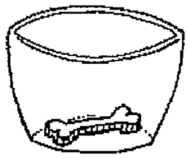
1. Cut the sponge into the shape of a bone. Place it in the bottom of the mixing bowl.

2. Cover the sponge completely with sand.

3. Stir 150 ml of salt into the 250 ml of very warm water. Pour the salty water over the sand in the mixing bowl. Try to soak the sand completely.

4. Label the bowl with your group's name and place it in a warm place for a couple of days.

5. After the water has evaporated and the sand is dry, dig out your fossil "bone" and observe any changes in the sponge.

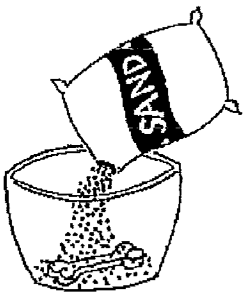


bone-shaped sponge in mixing bowl

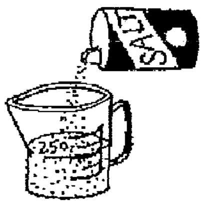
250 ml warm water

150 ml salt

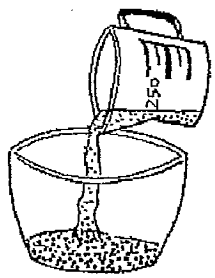
several cups of sand



cover sponge with sand



add salt to warm water



add solution to sand and sponge

Fabricando Fósiles

Hoja de Actividad para el Estudiante

Descripción: Se usarán dos técnicas diferentes para simular cómo se pueden formar los fósiles.

Materiales para Su Grupo:

Parte I
una barra de plastilina
1-2 conchas de mar pequeñas y/o
una hoja con venas profundas
vaselina
1/2 taza de yeso
un vaso de cartón
una tablilla para menear
agua

Parte II
una esponja comercial pequeña
150 ml de sal
250 ml de agua tibia
un tazón para mezclar
varias tazas de arena
tijeras

Procedimiento:

Parte 1: Fabricando Moldes y Vaciados

1. Desenrollar una capa de plastilina de 1-2 cm de espesor y hacer un bordo alrededor del contorno del barro.

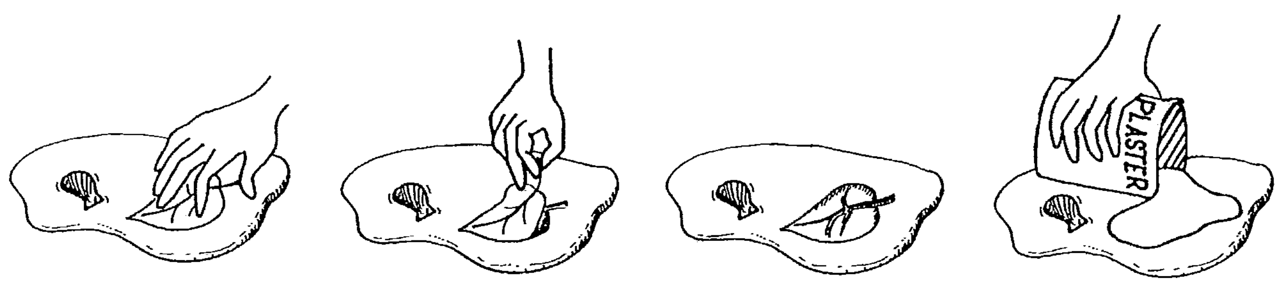
2. Presionar las conchas o una hoja con venas gruesas en el barro y luego quitarlas cuidadosamente. Has formado un molde en la plastilina.

3. Aplicar una capa delgada de vaselina sobre la superficie de la plastilina.

4. Llenar con yeso hasta la mitad el vaso de cartón, agregar agua gradualmente y menear hasta que la mezcla se vuelva gruesa y cremosa.

5. Vaciar la mezcla de yeso en las impresiones de plastilina y dejarla endurecer.

6. Después de cuando menos un día, retirar la plastilina para ver el vaciado y cuidadosamente limpiarlo de cualquier resíduo de vaselina.



Parte 2: Fósil Petrificado

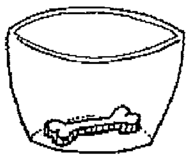
1. Cortar la esponja en la forma de un hueso. Colocarla en el fondo del tazón para mezclar.

2. Cubrir completamente la esponja con arena.

3. Mezclar 150 ml de sal en 250 ml de agua bien tibia. En el tazón, vaciar el agua salada sobre la arena. Tratar de remojar la arena completamente.

4. Rotular el tazón con el nombre de su grupo y colocarlo en un lugar tibio por un par de días.

5. Después de que el agua se haya evaporado y la arena esté seca, sacar el fósil (el hueso) y observar cualquier cambio que haya en la esponja.

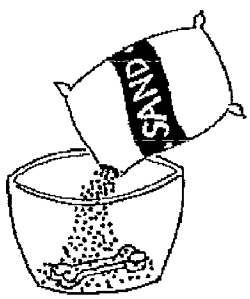


esponja en la forma de un hueso dentro de una charola

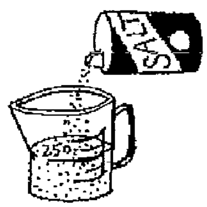
250 ml de agua tibia

150 ml de sal

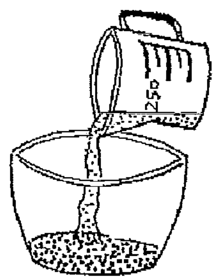
varias tazas de arena



cubre la esponja con arena



agrega la sal al agua tibia



agrega la disolución a la arena y la esponja

AMBER FOSSILS

Teacher Demonstration

Grades		
2-6	whole class	20 min.

Description: You will simulate the process by which insects become fossilized in amber.

Materials for Whole Class:

dead insects	water
sugar	molasses
Karo syrup	shallow tray
large beaker	burner
metal pan	safety goggles
stirrer	apron

Safety: Wear the safety goggles when using the burner; be aware of possible beaker breakage.

Procedure:

1. Mix 200 ml sugar, 100 ml Karo syrup and 100 ml water in a beaker.
2. Boil the solution in a pan for about 10 minutes. To test for "doneness," dip a small amount in cool water; it should become brittle.
3. Add molasses, one drop at a time, until the mixture reaches the desired yellowish-amber color.
4. Remove the mixture from the burner. Pour it into a shallow tray.
5. Drop several dead insects into the mixture. When the solution cools, it will harden and encase the insects.

Questions to Ask During the Activity:

1. How do you think insects became trapped in amber; what attracted them to the resin? [resin is sweet; possible source of food for insects]
2. Why don't insects decompose in the resin? [They are protected from microorganisms and the air.]

3. Why might scientists learn more from studying insects preserved in amber than from studying imprints? [They can see complete structures rather than just their external imprint.]

Why It Happens: Amber is a fossil gum from the sap of ancient plants. Insects and spiders were sometimes trapped in the amber and preserved. After the gum-like resin hardened, the insect or spider dried to almost nothing. Certain structures such as heads, antennae, wings, bodies and legs were well-preserved.

References: Project Storyline: Science, Primary Geology. California Science Implementation Network, Unversity of California at Irvine, 1993.

MICROFOSSILS

Grades		
3-6	individuals/ pairs	30 min.

Description: Students will simulate the experience of hunting for microfossils.

Materials per Student or Group: hand lens
microfossil sheet (next page)

Procedure:

1. Use the hand lens to search through the "Fossil Hunting Ground" for fossils. Use the key on the page to identify what you find.

2. Keep track of the types of fossils you find and how many of each kind. You can color each type of fossil a different color.

Questions to Ask During the Activity:

1. What creatures appear to have been living in this community?

2. Can you identify any possible predators and prey? [crocodile and lizard, for example]

Why It Happens: Microfossils come from very small animals and parts of animals. They range from tiny lizard jaws and fish scales to baby dinosaur bones and mammal teeth. These fossils were long overlooked simply because they are so small. Microfossils have become more and more important to paleontologists as they try to understand the community of animals that existed when the dinosaurs were alive.

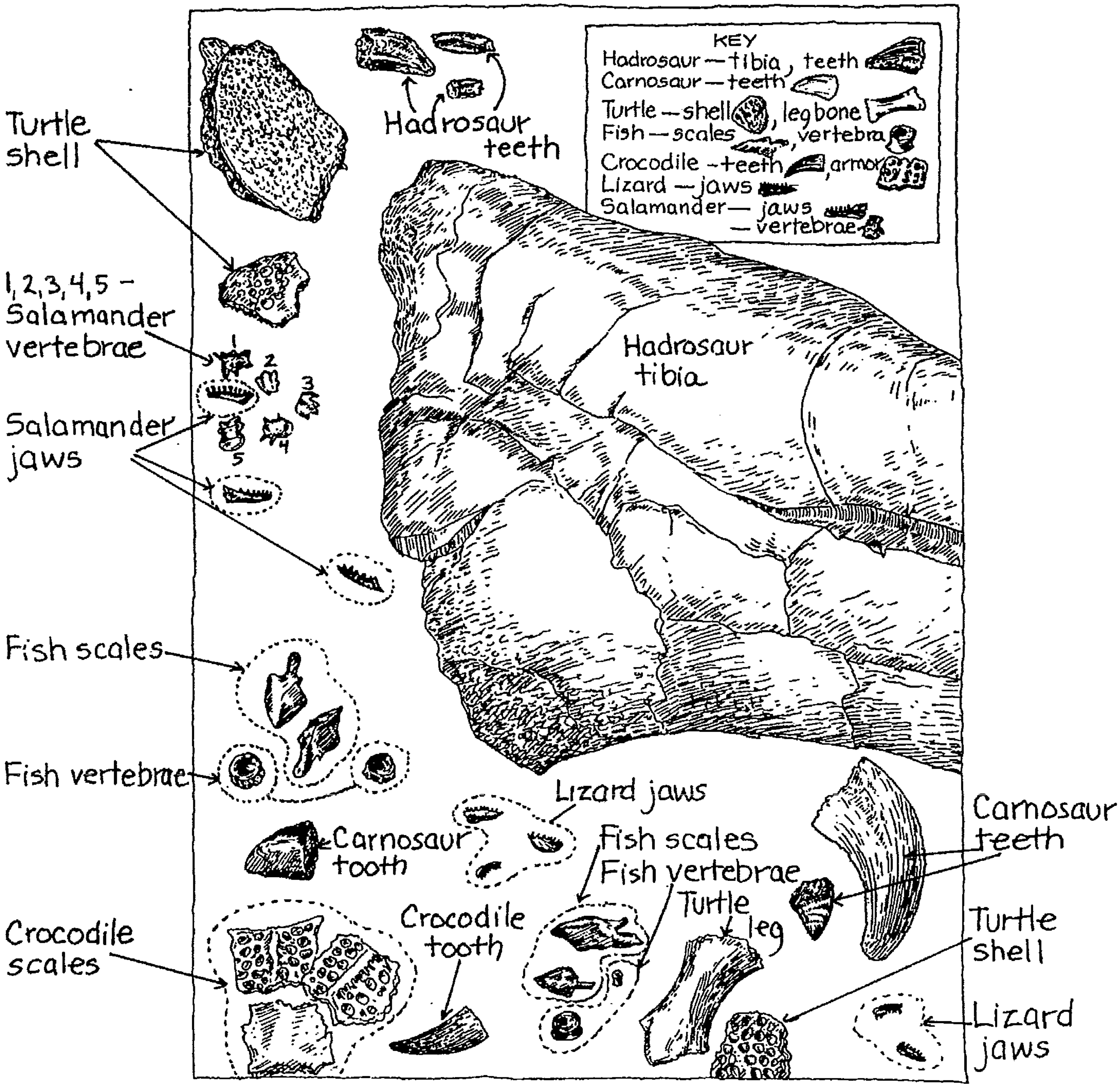
Extensions: Have students draw or find pictures of the creatures whose fossils they found.

References: Booth, Jerry. The Big Beast Book-Dinosaurs and How They Got That Way. Boston: Little, Brown & Co., 1988.

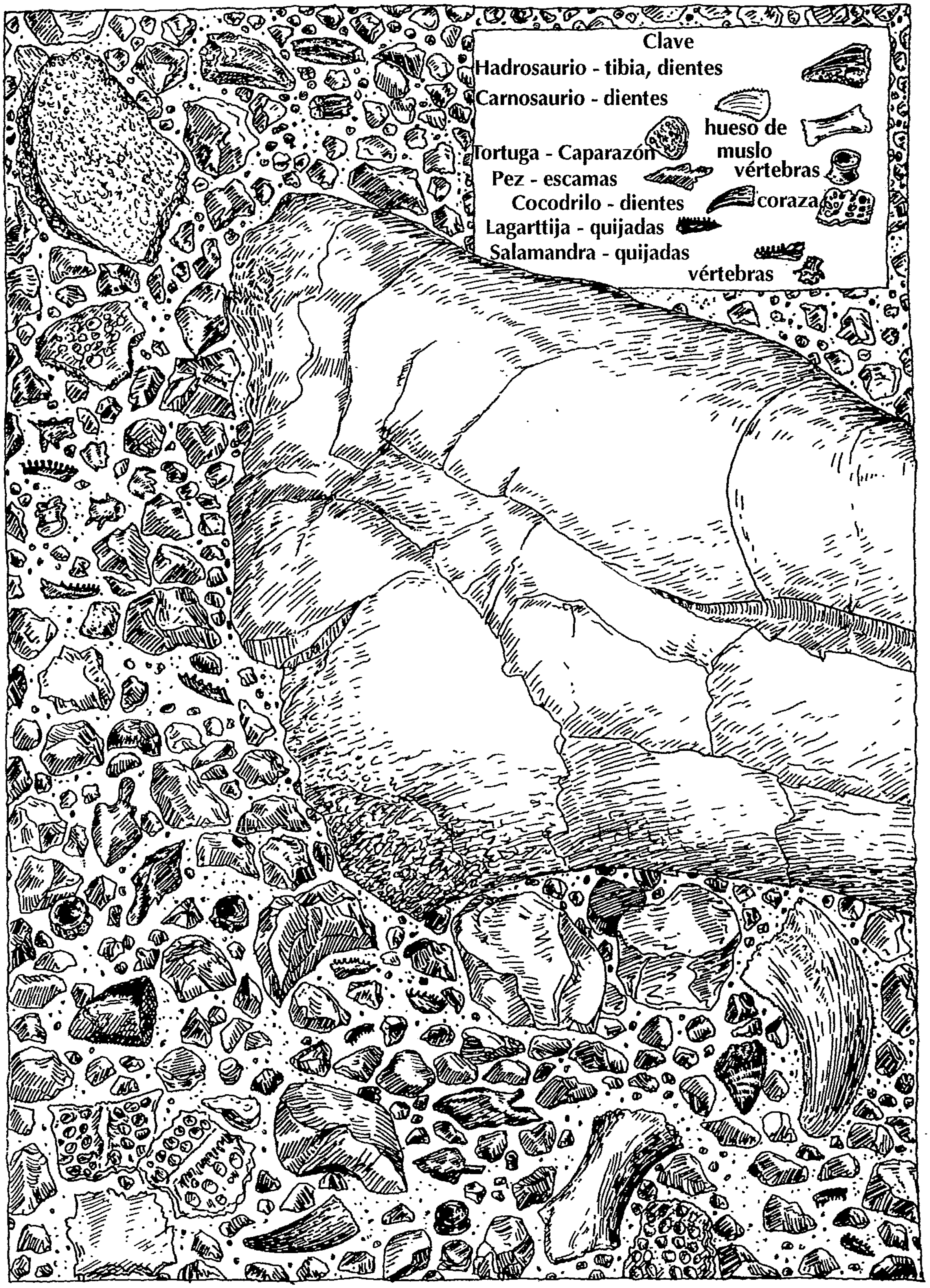
Fossil Hunt

From *The Big Beast Book-Dinosaurs and How They Got That Way*, Little, Brown & Co., 1988.

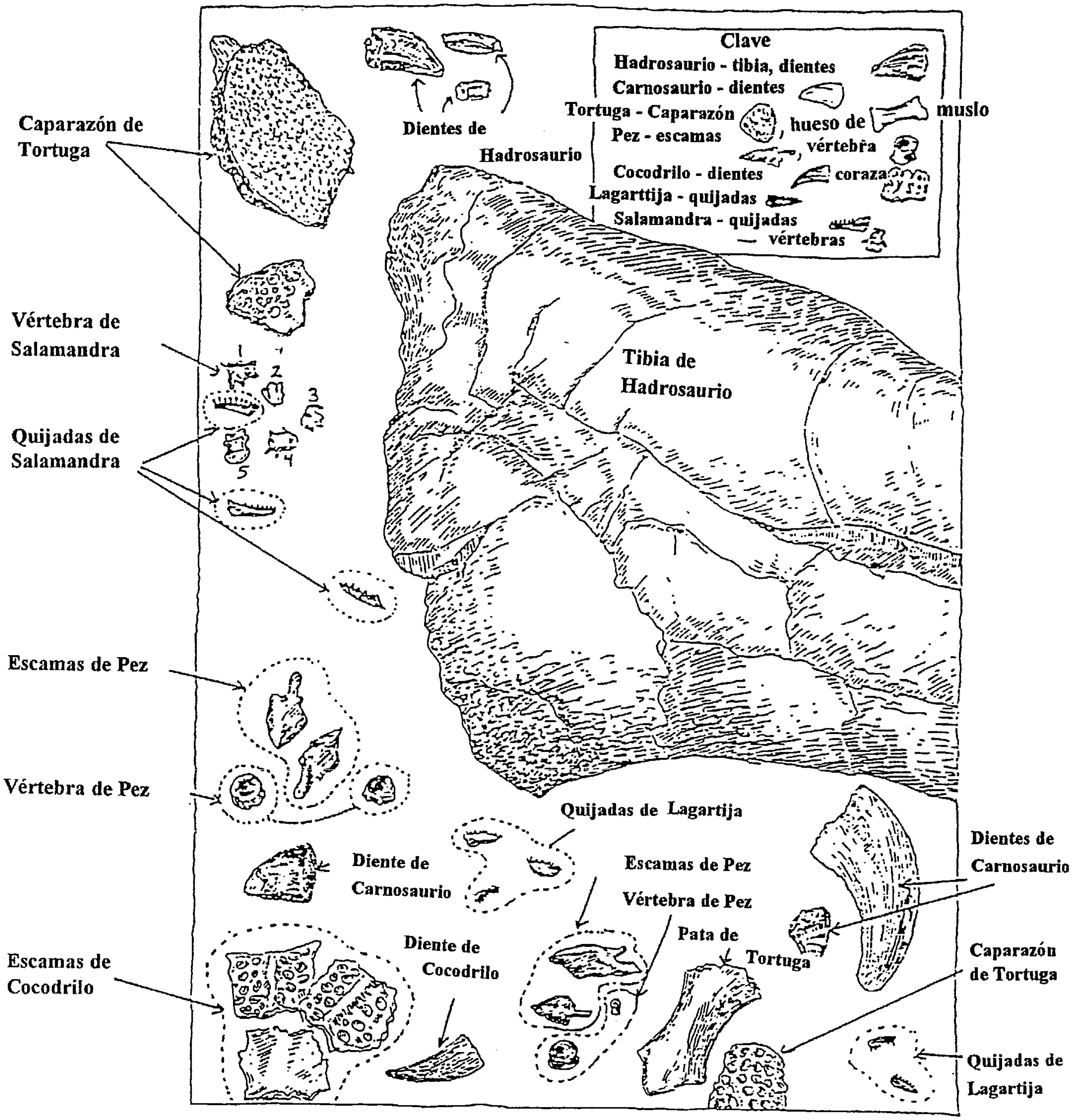
Fossil Hunt Key



From *The Big Beast Book-Dinosaurs and How They Got That Way*, Little, Brown & Co., 1988.



From *The Big Beast Book-Dinosaurs and How They Got That Way*, Little, Brown & Co., 1988.



From *The Big Beast Book-Dinosaurs and How They Got That Way,* Little, Brown & Co., 1988.

PROYECTO
FUTURO

DIGGING UP DINOSAURS

Grades		
4-8	pairs	40 min.

Description: Students will try to reconstruct a dinosaur from a jumble of bones, simulating the work of paleontologists.

Materials for Each Group:
Student Hand Out
glue
scissors
construction paper
pictures of skeletons of modern vertebrates

Procedure:

1. Use the pictures of modern animal skeletons to note similarities in their structures. For example, vertebrates have a spine, at one end of which is a head and the other end is a tail. The spine is supported by two pairs of legs. Note as many common characteristics as possible.

2. Make sufficient copies of the dinosaur skeleton pages for your class. Cut apart the bones and place them in envelopes. Depending on the developmental level of your students, you can keep the bones for each skeleton separate or mix 2-3 skeletons. You can also remove key bones (such as the skull) to increase the challenge for students.

3. Give students the envelope of bones, glue, scissors and construction paper. Tell them to dump out the bones into a small pile on the table. This is their bone collection. Their job is to sort out the bones into a skeleton (or several if you have put more than one in the envelope). There is no "correct" answer; any reasonable assembly is acceptable as long as they can defend their choices.

4. Have each pair display the assembled dinosaurs and explain how they decided on the best way to arrange the bones. Encourage students from different groups to compare their work.

Questions to Ask During the Activity:

1. How do scientists put together the skeletons of dinosaurs? [see Why It Happens]

2. What kinds of problems do you think they have to cope with while working in the field and in the lab?

3. Which bones were the hardest/easiest to place with the skeletons?

4. Did everyone's skeletons turn out the same?

5. Do you think that paleontologists have ever placed the wrong bones together in a skeleton? [they have]

Why It Happens: Paleontologists use the skeletons of modern animals as patterns to help them determine how the pieces of dinosaur skeletons might go together. The job of reconstructing these dinosaur skeletons is complicated by the fact that sometimes bones are missing, or they may be scattered over a large area. Bones may be broken, and they may be mixed in with the bones of several different animals. As new information about dinosaurs is uncovered, scientists sometimes have to reassemble dinosaur skeletons in light of the new information.

Adaptations for Participants with Disabilities: Students with visual impairments may need to work with a partner.

Extensions: Have each pair prepare a "news release" about their discoveries and hold a press conference in which they answer questions from the class.

Invite a paleontologist to speak to students about his/her work.

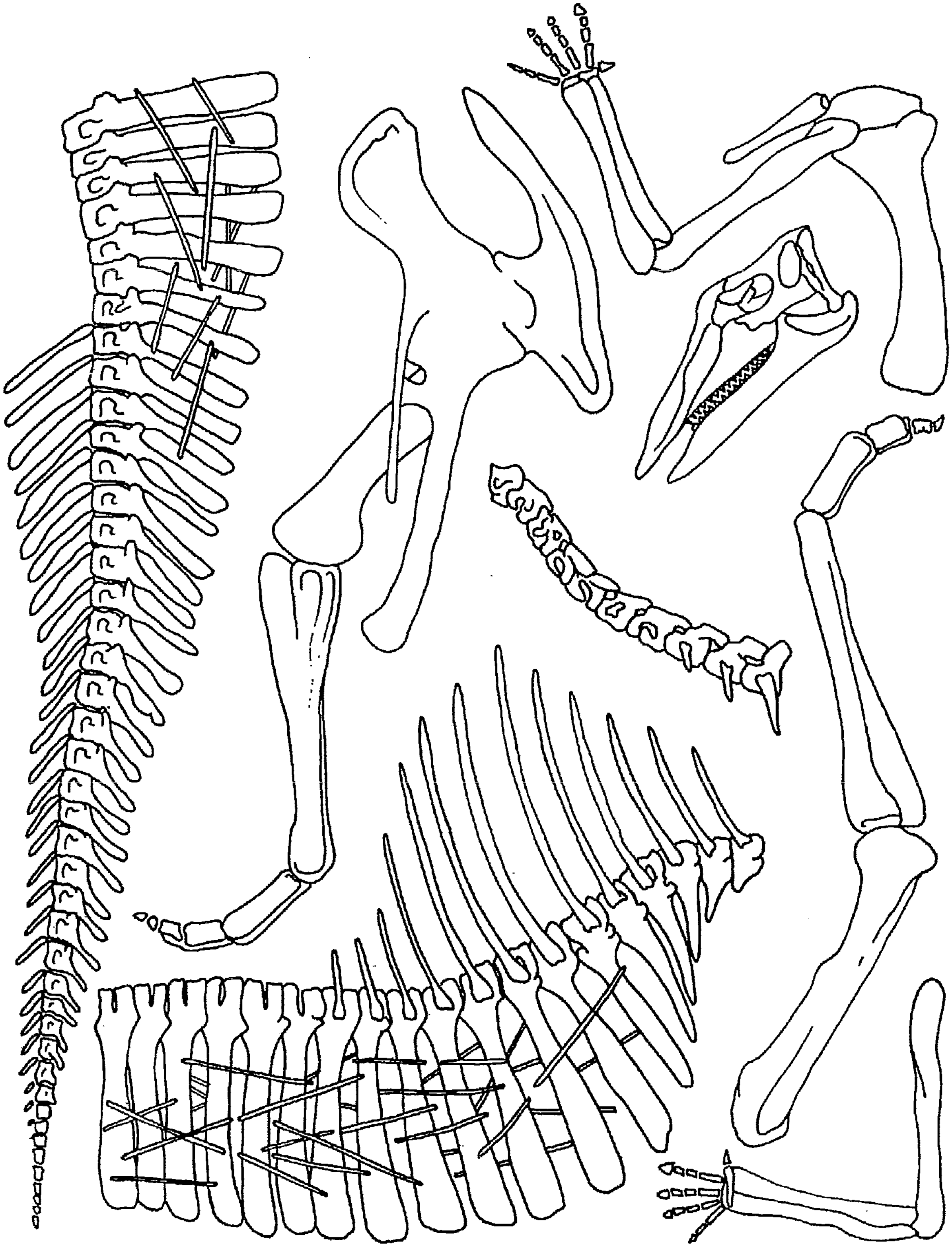
Visit the New Mexico Museum of Natural History and Science to see how paleontologists have discovered, preserved, and reconstructed dinosaur skeletons.

References:

Booth, Jerry. The Big Beast Book—Dinosaurs and How They Got That Way. Boston: Little, Brown & Co., 1988.

Munsart, Craig A. Investigating Science with Dinosaurs. Englewood, CO: Teacher Ideas Press, 1993.

OURANOSAURUS skeleton
Esqueleto de un *OURANOSAURIO*



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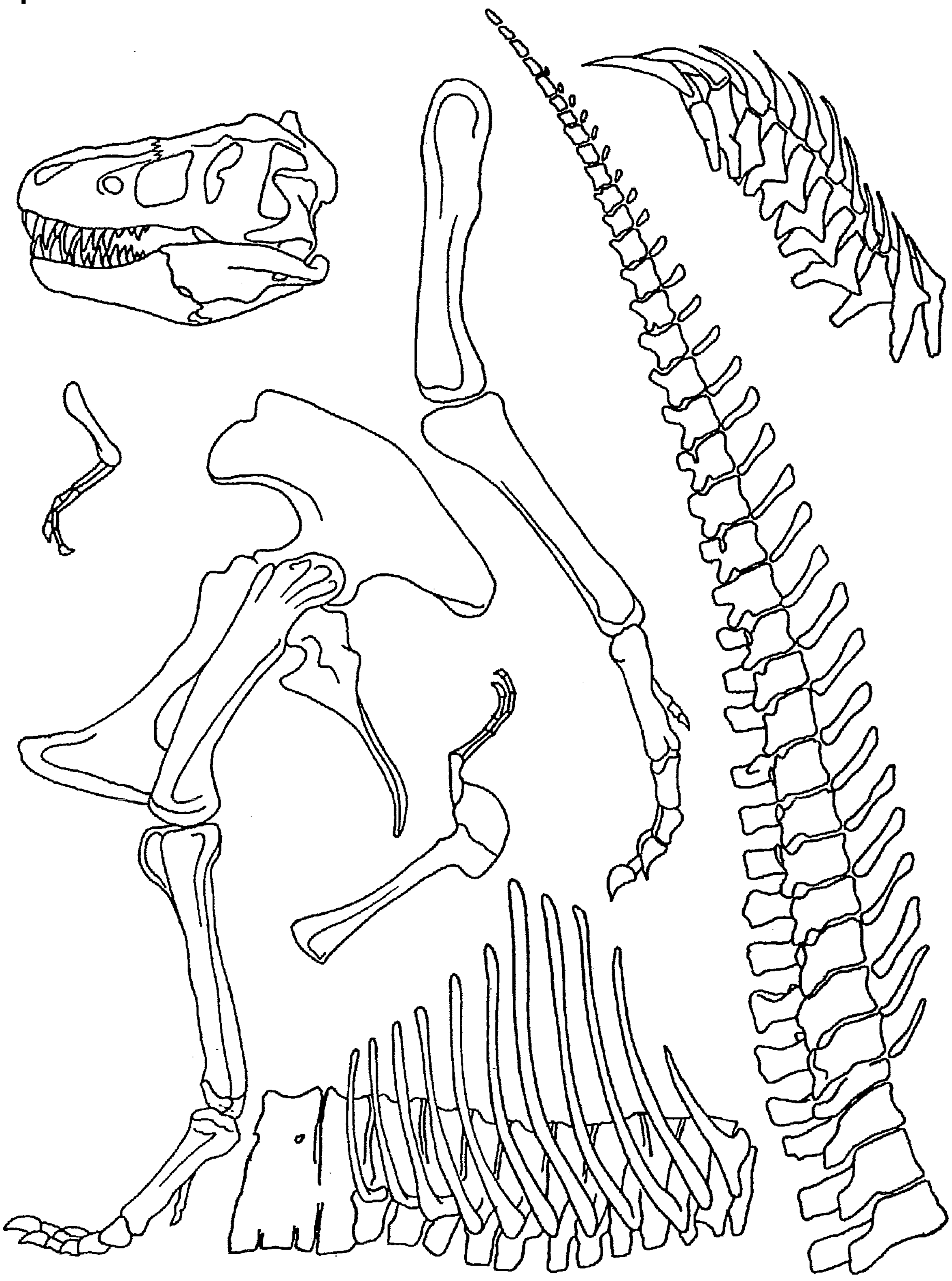
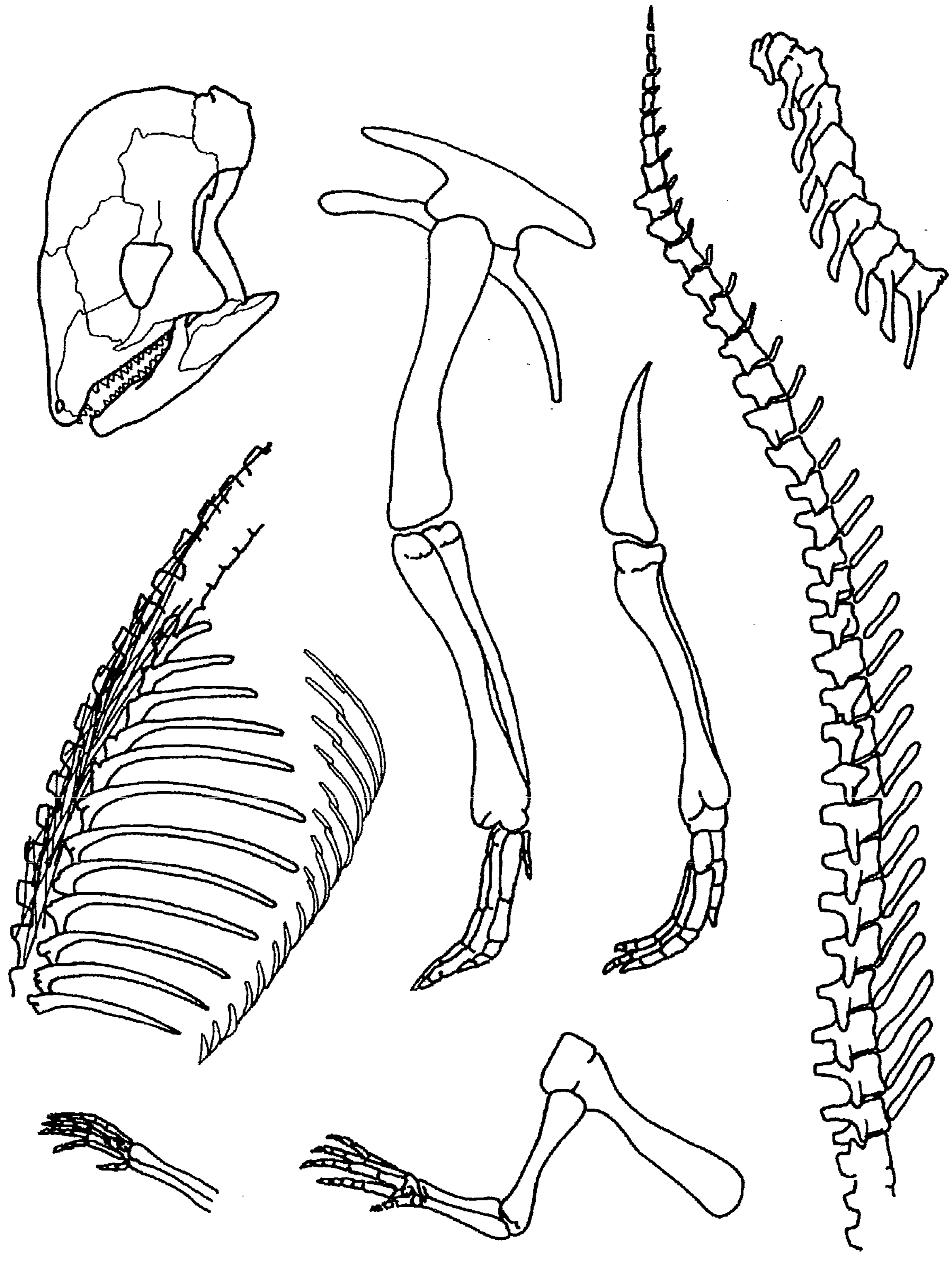
TYRANNOSAURUS skeleton
Esqueleto de un *TIRANOSAURIO*



STEGOCERAS skeleton
Esqueleto de un *ESTEGOSAURIO*



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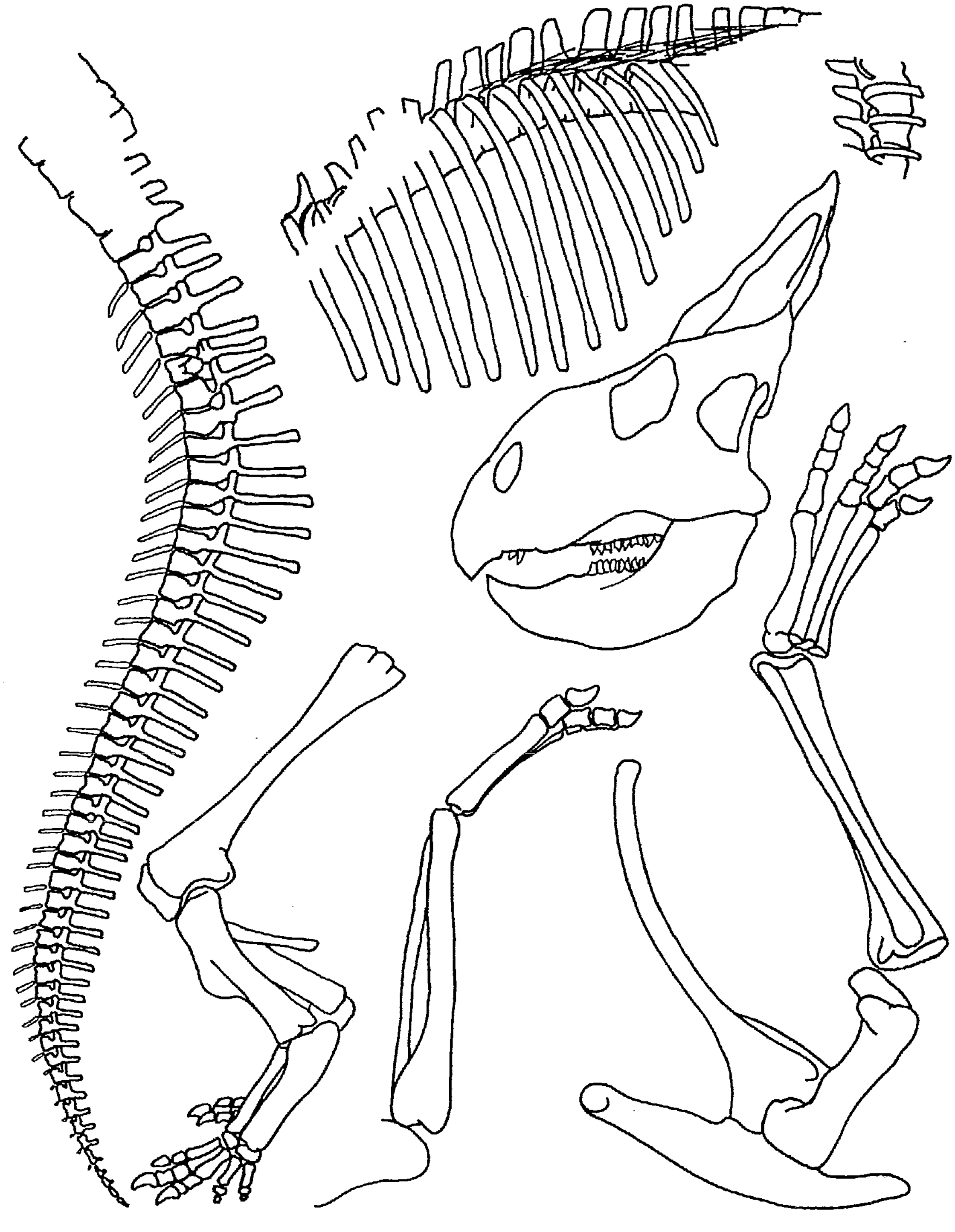
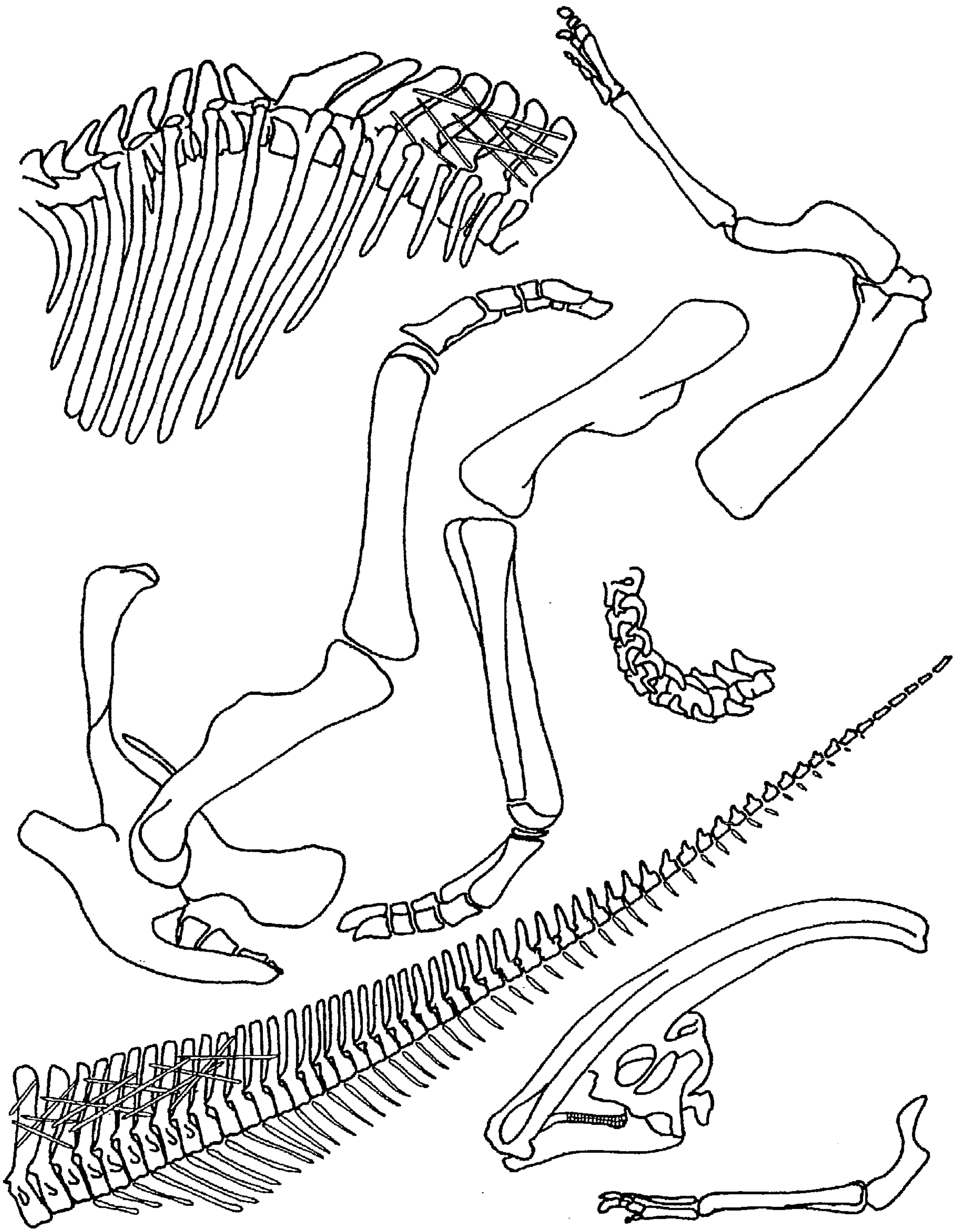
PROTOCERATOPS skeleton
Esqueleto de un *PROTOCERÁTOPO*



PARASAUROLOPHUS skeleton
Esqueleto de un *PARASAURÓLOPO*



CENTROSAURUS skeleton
Esqueleto de un *CENTROSAURIO*