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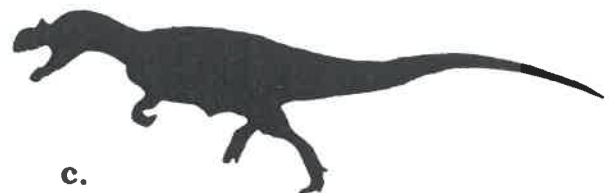
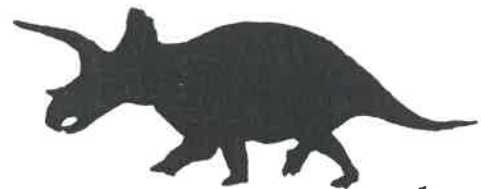
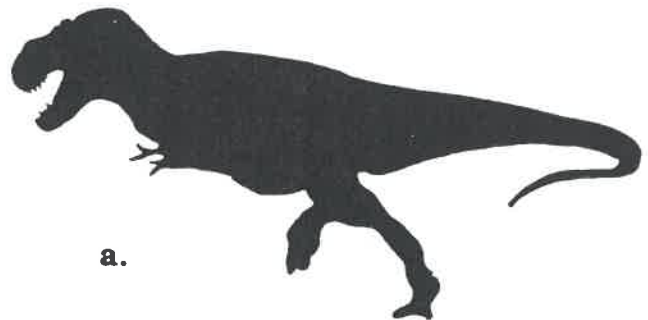
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## DINOSAURS OF SOUTH DAKOTA

### What Is A Dinosaur?

Dinosaurs, the most varied and abundant *vertebrate* animals that have lived on earth, roamed what we now call South Dakota during the *Mesozoic Era*. The name dinosaur comes from the Greek words *deinos*, meaning terrible, and *sauros*, meaning lizard. South Dakota dinosaurs included: huge, slow-moving plant eating species; fierce, aggressive predators; and small, fast-moving, meat eaters. For 180 million years, these "terrible lizards" were the most successful species on earth and, at least during the *Jurassic* and *Cretaceous* periods of the *Mesozoic Era.*, were part of the ecosystem of the land known today as South Dakota.

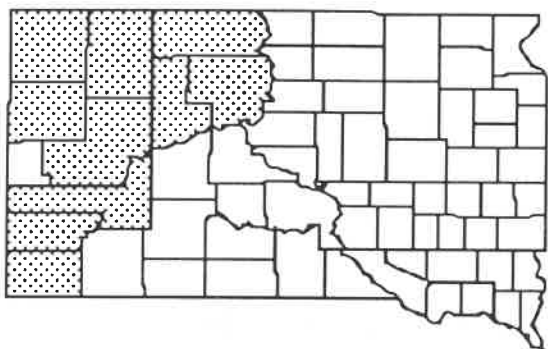
In spite of their diversity, dinosaurs are a very distinct group of reptiles and have a common ancestry with, not only turtles, snakes, lizards, and crocodilians, but also *pterosaurs* and a host of other extinct forms. Dinosaurs are different from other reptiles by having an ankle joint that is parallel to the ground, with ankle bones above and below the joint. For this reason, dinosaurs do not include the extinct reptile groups such as *plesiosaurs*, *ichthyosaurs*, *mosasaurs*, or *pterosaurs*.



**Figure 1. Some of the Famous Dinosaurs of South Dakota: a. Tyrannosaurus; b. Triceratops; and c. Allosaurus.**

*Pterosaurs* are the most closely related group to dinosaurs, unless birds can be shown to be directly descended from dinosaurs, as many researchers suspect today. Among living reptiles, alligators and crocodiles also are closely related to dinosaurs. Snakes and lizards are more distantly related.

Although most people associate the word dinosaur with giants, such as *Apatosaurus* (formerly *Brontosaurus*), or fierce predators, such as *Tyrannosaurus*, some dinosaurs were quite small. The largest dinosaur that has been found in South Dakota is a *Barosaurus lentus*, measuring more than 65 feet (20 m) in length. The smallest adult specimen known from South Dakota is a *carnivorous* dinosaur with a bird-like skull, *Troodon formosa*, which was 5.5 feet (1.7 m) long.



**Dinosaur Fossil Locations**

## Where Were Dinosaurs Found In South Dakota?

Dinosaurs were known principally from two areas in South Dakota: along the ridge known as the *Hogback* that forms the outer boundary of the Black Hills; and in the counties of the northwestern corner of the state. From the *Hogback* ridge, dinosaurs have been recovered from rocks of the late *Jurassic* and early *Cretaceous* periods. Appropriately, Dinosaur Park in Rapid City is built on this ridge. The northwestern corner of

the state has produced most of the dinosaurs found in South Dakota. The rocks in this area that contain dinosaurs were formed in the late *Cretaceous* Period.

## What Dinosaurs Were Found In South Dakota?

Nearly all of the major groups of dinosaurs were represented in South Dakota. Exceptions are the Prosauropoda, which are primitive versions of gigantic *Sauropods*, and the *Stegosauria*. Neither group, as yet, has been found in South Dakota deposits. Dinosaur groups known from South Dakota include both the reptile-hipped (see Figure 2) and the bird-hipped forms (see Figure 3).



**Figure 2. Hip Bones From Saurischian Dinosaurs (Reptile-hipped Forms).**

Reptile-hipped dinosaurs from South Dakota were *Theropods* (including carnosaurs, dromaeosaurs, and ornithomimids) and *Sauropods*, (the giant *quadrupedal herbivores* such as *Brontosaurus*).



**Figure 3. Hip Bones From Ornithischian Dinosaurs (Bird-hipped Forms).**

The bird-hipped dinosaurs from South Dakota included:

Thyreophorans (armored dinosaurs) including nodosaurids and ankylosaurids;

Ornithopods - *bipedal* plant eaters including hypsilophodontids, iguanodontids, and hadrosaurids, and;

Marginocephalians - the dinosaurs with bony frills on the back of their skulls including pachycephalosaurids and ceratopsids, such as *Triceratops*.

## **When Did The Dinosaurs Live In South Dakota?**

Dinosaurs lived in South Dakota during the late Jurassic Period, about 150 million years ago, the early Cretaceous Period, about 125 million years ago, and late Cretaceous Period ranging from 80 to 66 million years ago.

## **Under What Conditions Did Dinosaurs Live?**

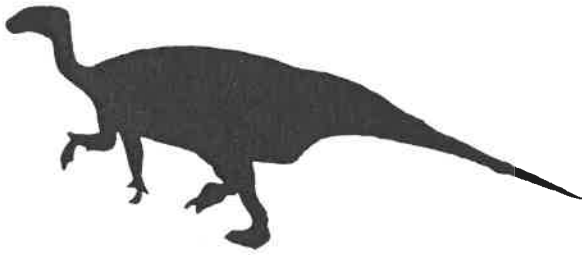
South Dakota, at the time of the dinosaurs, was a very different place. South Dakota dinosaur habitats included broad open flood plains, shores along sandy bottomed streams that were well

removed from the oceans, and land along coastal plains and rivers at the upper end of deltas. (At the time of the dinosaurs, part of South Dakota was covered by an inland sea, as evidenced by our finding marine fossils in the state today.) The climate at the time of the dinosaurs was probably warmer and more moist than what we currently experience in South Dakota.

## **What Are the Dinosaur-Containing Rock Formations in South Dakota?**

The **Morrison Formation**, around the outer rim of the Black Hills outside of the *Hogback*, contains rocks that are approximately 150 million years old. They formed when the climate had a well-defined wet and dry season and quite warm average annual temperatures. Specimens found in the Morrison Formation include *carnivorous* dinosaurs, *Theropod* footprints, *Allosaurus fragilis*, *Stokesosaurus*(?), Sauropods, *Camarasaurus*, and *Apatosaurus* (also known as *Brontosaurus*). *Barosaurus lentus*, first recognized by Professor Marsh in 1890 based on a partial skeleton from Piedmont, SD, was also taken from the Morrison Formation.

The **Lakota Formation**, approximately 125 million years old, is found in the *Hogback* that surrounds the outer edge of the Black Hills and includes Dinosaur Park in Rapid City. It was formed in a north flowing stream system that accumulated deposits in a warm climate some distance from an ocean. Fossils from the Lakota Formation include *carnivorous* dinosaurs, *Theropod* footprints, the Thyreophoran, *Hoplitosaurus marshi*, and Ornithopods such as a Hypsilophodontid skeletal part that cannot be assigned to a specific dinosaur, *Iguanodon lakotaensis* related to the more famous English *Iguanodon*, and *Camptosaurus depressus*. (See Figure 4.)



**Figure 4. Iguanodon**

The **Pierre Shale** deposits are approximately 80 million years old and represent a *marine* mud formed some distance from land. Pierre shale is found on the prairie east of Rapid City to the Missouri River, along the Belle Fourche River from Newell eastward, and south of the Black Hills to Nebraska. A Hadrosaurid called *Claosaurus affinis*, having died and floated out to sea, has been found in these rocks.

The **Fox Hills Formation**, approximately 69 to 70 million years old, formed in a delta deposit close to the ancient inland sea that once covered large areas of the mid-continent during a time of warm, moist climate. It is found today in Corson, Dewey, Ziebach, Butte, Harding, Pennington, and Meade counties. *Carnivorous* dinosaur fossils known from the Fox Hills Formation were:

*Troodon formosus*, a small predator  
 Dromaeosaurid (related to  
*Deinonychus*, which is an early  
 Cretaceous form)  
*Struthiomimus*, an ostrich dinosaur  
 Nodosaurids  
 Hadrosaurid *Edmontosaurus* (?)  
 Ceratopsid *Triceratops* (?)

The **Hell Creek Formation**, located in northwestern South Dakota, southwestern North Dakota, and eastern Montana, contains rocks approximately 66 to 68 million years old. They were formed in the upper reaches of a delta, under warm and moist conditions. Specimens

of the following dinosaurs have been found in this formation:

Carnivorous dinosaurs:

*Tyrannosaurus rex*  
*Nanotyrannus lancensis*  
*Troodon formosus*  
 Dromaeosaurid

*Ornithomimus* an ostrich dinosaur  
 (see Figure 5)

Nodosaurids (armored dinosaurs):

*Edmontonia*  
*Denversaurus schlessmani*

Ornithopods:

*Thescelosaurus neglectus*  
*Thescelosaurus?*

Hadrosaurids:

*Edmontosaurus regalis*  
*Edmontosaurus annectens*  
*Anatotitan copei*

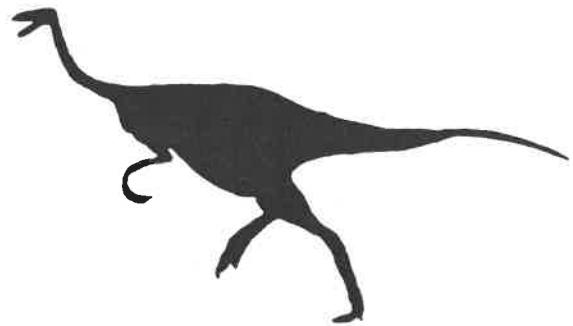
Pachycephalosaurids

(bone headed dinosaurs):

*Pachycephalosaurius wyomingensis*

Ceratopsids (horned dinosaurs):

*Triceratops horridus* (the South  
 Dakota State Fossil)  
*Torosaurus latus*



**Figure 5. Ornithomimus**

## Conservation Measures

Fossils are documents of the past and are valuable to museums for current and future study and as a resource for the public. People are encouraged to participate with museums in protecting South Dakota's fossil heritage. Often, much of

the valuable information about a fossil is lost if the specimen is removed from the rock deposit, before accurate records are made. In addition, amateur collectors could inadvertently damage specimens when trying to remove them from surrounding rock and soil. If you locate any significant fossil deposits, contact the Museum of Geology at the S.D. School of Mines and Technology before disturbing the site.

Collectors must have permission from landowners in order to look for and collect specimens from private land. It is illegal to collect fossils from Tribal lands without permission from the Tribal authorities. For permission to fossil hunt along highway right-of-ways, contact the nearest Department of Transportation Office (see the Rose Quartz fact sheet for addresses). Regulations on public lands vary. People always should contact the land manager before disturbing geological formations.

### Glossary

**Bipedal** - locomotion on two feet, almost always the hind legs.

**Carnivorous** - meat eating.

**Cretaceous** - the period of geologic history following the Jurassic Period and ranging from about 144 million years ago until 65 million years ago.

**Herbivorous** - plant eating.

**Hogback** - the geologic ridge that contains rocks about 125 million years old and forms the outer boundary of the Black Hills.

**Ichthyosaurs** - the most highly specialized of the extinct, marine, fish-like reptiles.

**Jurassic** - the period of geologic history preceding the Cretaceous and ranging from about 208 until 144 million years ago.

**Marine** - inhabiting the sea or ocean.

**Mesozoic Era** - that time in geologic history of the earth ranging from about 248 million years until 65 million years ago; the three periods in the Mesozoic Era are the Triassic, Jurassic, and Cretaceous.

**Mosasaurs** - lizards that lived in marine habitats in the late Mesozoic.

**Plesiosaurs** - large, marine reptiles, many with long necks and flipper-like legs, which became extinct by the end of the Mesozoic Era.

**Pterosaurs** - reptiles of the Mesozoic Era that were capable of true flight.

**Quadrupedal** - walking on four legs.

**Sauropods** - large, quadrupedal, plant-eating dinosaurs, such as *Apatosaurus*.

**Theropods** - carnivorous dinosaurs that included large predators such as *Tyrannosaurus* as well as small, fast-running meat eaters.

**Vertebrate** - animals with a backbone.

### References

Museum of Geology Collection, SD School of Mines and Technology, Rapid City, SD 57701.  
Weishapel, D.B., P. Dobson, and H. Osmolska, ed. 1990. The Dinosauria, University of California Press, 733 pp.

## Selected Resources for Teachers

*Dinosaurs of North America* by Helen R. Sattler, 1981. Lothrop, Lee and Shephard Books, NY.  
*Illustrated Encyclopedia of Dinosaurs* by David Norman, 1994. Crescent Books. This volume has excellent pictures of skeletons and reconstructions.

**Museum of Geology Field Paleontology** offerings are available to teachers for credit and high school students for no-credit each summer. Participants spend one to two weeks working at a fossil dig. For details and costs contact the Museum of Geology for a brochure.

*The Dinosaur Society Dinosaur Encyclopedia* by Don Lessem and Donald Glut, 1993. Random House, New York. This book is great for information relating dinosaurs and world geography.

## Outreach

Black Hills Institute of Geological Research is a for-profit business in Hill City that displays fossils and sells educational materials. 217 Main Street, Hill City, SD 57745.

Museum of Geology of the SD School of Mines and Technology has excellent fossil displays, seasonal field trips, and educational materials. S.D. School of Mines and Technology, 501 E. St. Joseph St., Rapid City, SD 57701.

Petrified Wood Park Museum exhibits fossils. 500 Main Ave., Lemmon, SD 57638.

Timber Lake and Area Museum has fossils, educational materials and field trips to fossil bed sites. P.O. Box 181, Timber Lake, SD 57656.

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