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## MARINE REPTILES OF SOUTH DAKOTA

### What Are Marine Reptiles?

Perhaps an easier question to answer is, what are they not? They are not dinosaurs. No dinosaurs are known that lived in the ocean. During the Mesozoic Age, or Age of Reptiles as it is sometimes called, several other groups of reptiles became aquatic and had successful lives in the sea. Today, only a few representatives of four reptilian groups live in salt water: turtles, crocodiles, lizards, and snakes. All of the salt water, or marine, living reptile species and those from the *Mesozoic*, are descended from *terrestrial* ancestors. Amazingly, many varieties of terrestrial reptiles reverted to an aquatic life.

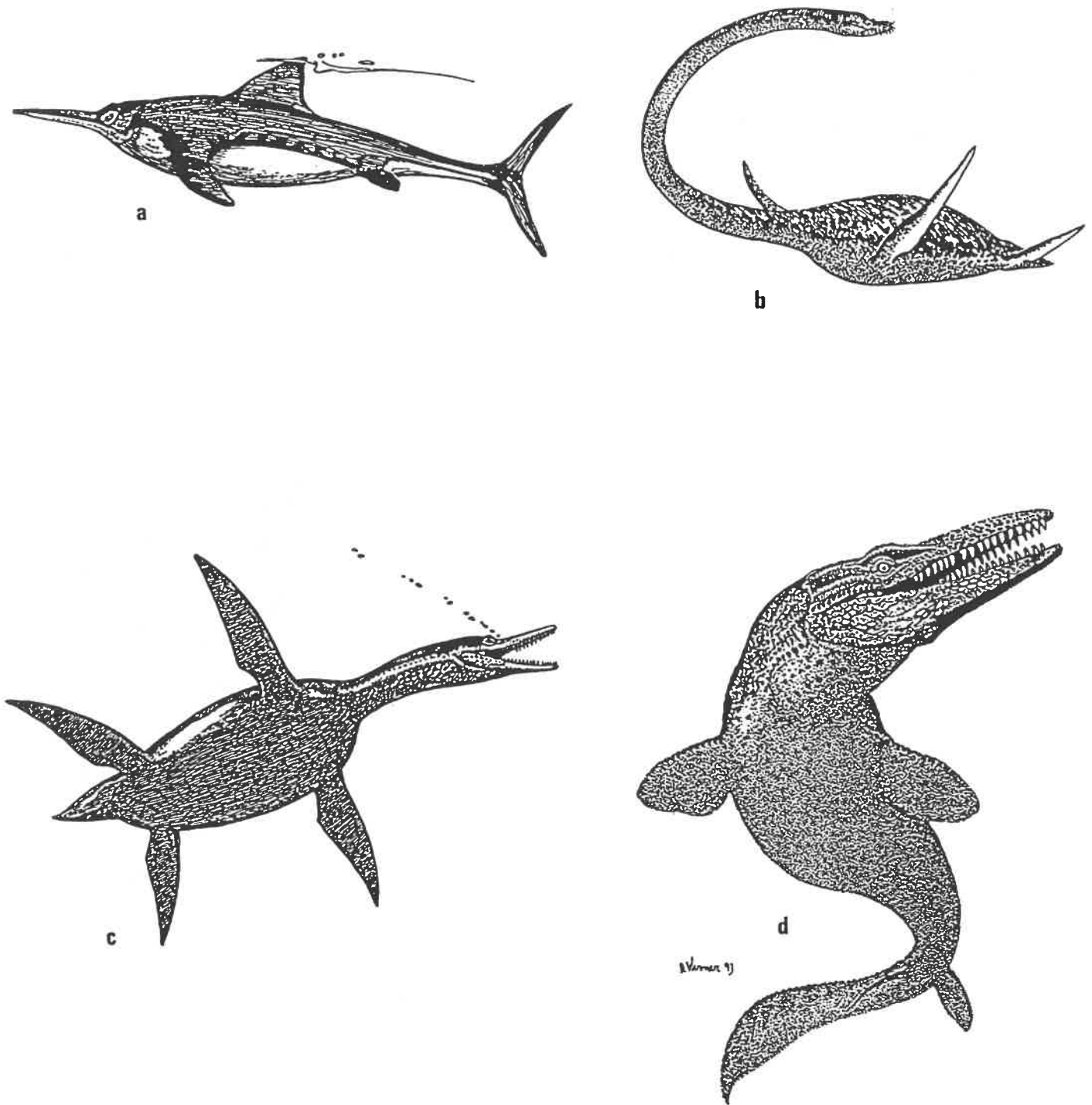
The variety of *Mesozoic* marine reptiles includes crocodylians called mesosuchi-ans, mollusk-crushing placodonts, the small nothosaurs, plesiosaurs, ichthyosaurs, turtles, and mosasaurs. Mosasaurs, turtles, and plesiosaurs left impressive fossil records of their existence in the state. The ichthyosaurs have a meager record in South Dakota.

The marine reptiles are associated with diving marine birds, flying reptiles called pterosaurs, a variety of marine fishes, and a diverse assemblage of marine mollusks. These animals are found in



**Figure 1. Seaway that covered the central portion of North America during the late Cretaceous Period.** (Darkened area represents marine waters; South Dakota, which was covered by water, is highlighted).

two rock types, chalk and mudstones or shale. The chalk is composed of skeletons of many microorganisms and the mudstones are formed from silt and clay. These rock types were formed from de-



**Figure 2. Reconstructions of: a) ichthyosaur; b) long-necked plesiosaur (elasmosaurid); c) short-necked plesiosaur (pliosaurid); and d) mosasaur.** The scale is not relative among the illustrations. Animals b and d are largest (ranging to 12 meters) whereas a and c are in the 3 to 4 meter range.

posits on the bottom of a great shallow sea. Near the end of the Age of Reptiles, the sea extended from the Gulf of Mexico to the Arctic Ocean. Not only was South Dakota covered, but so was much of the continental interior (see Figure 1). With the passage of time, layers of mud, and more rarely layers of chalk, covered the skeletons of the marine reptiles on the sea floor. (For further information on the succession of geological formations consult Gries and Martin, 1985.) After the *Mesozoic*, the marine deposits were uplifted above sea level. Today they are being eroded over much of the West River area. Fossils of animals that lived here over 70 million years ago are being exposed.

## Description

### Ichthyosaurs

Ichthyosaurs are poorly represented in the marine rocks of South Dakota. These reptiles were most abundant during the *Jurassic Period* and declined in the late *Cretaceous Period*, when they became extinct. These creatures were well-adapted for a marine existence. Their body shape resembles that of a dolphin (Figure 2a). Most fossil specimens are less than 9.75 feet (3 meters) in length, although larger specimens have been recovered from California. Ichthyosaurs had pointed snouts armed with small, sharp teeth, well-suited for preying upon fishes. They had paired, short front paddles used primarily for steering. They propelled themselves with a tail that had a larger lower lobe as indicated by the distinct down-turned angle of the tail *vertebrae*. This tail structure resulted in a great upward propulsion force, advantageous to an air-breathing reptile that often needed to return to the surface. Well-preserved specimens from Germany supposedly indicate that ichthyosaurs had a streamlined body shape and a dorsal fin. Another remarkable specimen, a mother ichthyosaur that appears to have died while giving birth, definitely indicates live birth of the young. Ichthyosaurs were well adapted to the

marine environment. They were fast swimmers and efficient *predators* that had developed the ability to have live birth.

### Marine Turtles

A variety of sea turtles existed during the late *Cretaceous* in South Dakota. The giant of all sea turtles, *Archelon*, grew to a length of approximately 13 feet (4 meters). Smaller forms include *Toxochelys* and *Protostega*. All of the fossil turtles were similar in body shape to living sea turtles. They were propelled in a similar manner and probably crawled onto land to lay eggs. Two major groups dominated the ancient sea in South Dakota: the toxochelyids and the protostegids. Toxochelyids were small sea turtles, about 39 inches (1 meter) in length, and were similar to living leatherbacks. The protostegids had a distinctive beak. *Archelon* belongs to this group. This giant turtle lived at the end of the *Cretaceous* and is best known from specimens from our state.

### Plesiosaurs

In South Dakota, plesiosaurs have been found most commonly in late *Cretaceous* marine *shales*. These reptiles (Figure 2b, c) are represented by two major groups, although this classification is an oversimplification of their complex evolution. The elasmosaurids are long-necked forms with short heads, and the pliosaurids are short-necked with long heads. The descriptions of the mythical Loch Ness Monster in Scotland are superficially similar to animals in the long-necked group. The elasmosaurids attained lengths of over 39 feet (12 meters). They had exceedingly long necks for capturing fishes and small heads with interlocking sharp, pointed, grooved teeth. Elasmosaurids were propelled by four paddles, and were probably slower than their short-necked cousins. It is therefore thought that these long-necked varieties ambushed, rather than overtook, their prey.

The short-necked group looked like large

penguins with an extra set of swimming "wings." The pliosaurs in South Dakota were smaller than their long-necked relatives, ranging in length from 9.75 to 13 feet (3 to 4 meters). They had short necks and larger heads, normally with slender snouts armed with many sharp, grooved teeth. They appeared to have "flown" through the water, much like sea turtles and penguins. But, their paddle-like hind limbs provided additional thrust. These creatures may have been among the fastest reptiles in the *Cretaceous* seas.

Both plesiosaur groups have been found with stones (*gastroliths*) in their stomach region. *Gastroliths* are stones swallowed by animals that may have aided in digestion or served as ballast to help the swimmers achieve neutral buoyancy. The latter would improve efficiency in moving up and down in the water. Interestingly, not every fossil plesiosaur possesses these well rounded, polished stones. Another question concerns reproduction. Because of the overall primitive nature of these reptiles, many authors suggested the plesiosaurs crawled onto land to lay eggs in the manner of sea turtles. However, their large size and inability of the paddles to support much weight suggest that they may have given live birth. Recently, in southwestern South Dakota, a baby plesiosaur was found hundreds of kilometers from the shoreline of the ancient sea. Its occurrence in the middle of the sea suggests either live birth and/or parental care (Martin, 1994). Live birth is known in some reptiles such as snakes.

### **Mosasaurus**

The most commonly preserved reptiles in South Dakota are the mosasaurs. This diverse group outwardly resembled crocodiles with paddles (Figure 2d), although mosasaurs were more closely related to true lizards. Mosasaurs lived only during the late *Cretaceous*. In their short reign, they were the supreme *carnivores*, the tyrannosaurs of the seas. For instance, stomach contents of one South Dakota specimen contained re-

mains of fish, shark, diving bird, and another type of mosasaur (Martin and Bjork, 1987). Mosasaurs ranged in length from only 6.5 feet (2 meters) to over 32.5 feet (10 meters), were propelled by a long tail, and possessed a skull whose bones could flex to allow swallowing of larger prey. This condition is known in some modern lizards and snakes. Compared to ichthyosaurs and plesiosaurs, mosasaurs were extremely diverse, considering the relatively short time the group lived. Russell (1967) and, more recently, Bell (1993) reviewed the *taxonomy* of this group and found that 9 major types (*genera*) occurred commonly in North America. Of these, 7 have been found in South Dakota, making South Dakota one of the most important areas in the world for study of these unusual marine lizards.

## **Management Considerations**

*Vertebrate* fossils, including marine reptiles, are nonrenewable resources, and are rare compared to their *invertebrate* contemporaries. Each fossil found embedded in the rock must be documented. The geographic and *stratigraphic* (vertical) location should be noted. Additional factors that must be recorded are the specimen's orientation and state of preservation. Without this field documentation, much of the scientific importance of the fossil is forever lost. Moreover, *vertebrate* fossils may be extremely fragile, and proper collecting techniques must be employed to preserve the specimen.

After collection, management continues in the museum, where the specimen is carefully removed from the encasing rock and conserved to stand the test of time. The specimen must then be catalogued, including all associated field data, so it may be retrieved for research and educational purposes. If all these management considerations, from field documentation to *curation* and *conservation*, are completed, a fossil specimen will al-

ways be available for posterity.

## Regulations

Fossil specimens are not as well protected as endangered species or *archaeological* artifacts. However, federal and state regulations do exist. Fossil *vertebrates* and other scientifically significant fossils are protected on federal lands, and a permit must be obtained in order to collect these remains. *Invertebrate* and plant fossils, which are not scientifically important, may be collected without a

permit on federal land. Fossils on private land belong to the landowner, and permission must be obtained before one collects them.

Many museums have programs that allow the public to participate in scientific investigations. In South Dakota, the Museum of Geology at the S.D. School of Mines and Technology in Rapid City conducts such field courses, for which tuition and fees are charged.

## Glossary

**Aquatic** - referring to fresh or salt water habitats.

**Archaeological** - referring to the scientific study of the life and culture of ancient peoples.

**Carnivores** - meat eaters.

**Conservation** - stabilization and continued care of a fossil specimen in order that it survives through time.

**Cretaceous Period** - period of time at the end of the Age of Reptiles extending from approximately 66 to 145 million years ago.

**Curation** - removal of fossil from surrounding rock (preparation), cataloguing (numbering), and storage of specimen insuring retrieval for later educational purposes.

**Documentation** - record making; in paleontology, recording field occurrences, locations, geological position, specimen orientations, collection methods, preparation techniques, field maps, laboratory maps, photographs, etc.

**Gastrolith** - a stone that occurs in the stomachs of some animals.

**Genera** - a group in classification systems that contain one or more similar species.

**Invertebrates** - animals without backbones, such as clams, squids, ammonoids, snails, crabs, insects, etc.

**Jurassic Period** - period of time during the middle of the Age of Reptiles extending from approximately 145 to 208 million years ago.

**Mesozoic Era** - era of time equivalent to the Age of Reptiles, including the Triassic, Jurassic, and Cretaceous periods and extending from approximately 65 to 248 million years ago.

**Paleontology** - the study of ancient life, particularly plants and non-human animals.

**Predator** - an animal that obtains food by killing and consuming other animals.

**Pterosaurs** - extinct group of flying, lizard-like reptiles that lived in Mesozoic times.

**Shale** - a dark, fine-grained sedimentary rock that usually forms in deep, calm water.

**Stratigraphy** - the study of the succession of rock layers that were deposited on the earth's surface.

**Taxonomy** - classification system; in paleontology, a classification based upon close relationships of species.

**Terrestrial** - derived from the land surface, and sometimes considered to include derivation from freshwater.

**Vertebrae** - the bones of the spine and tail that protect the spinal cord.

**Vertebrates** - animals with backbones such as fishes, amphibians, reptiles, birds, and mammals.

## References

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- Martin, J. E., 1994, A baby plesiosaur from the Late Cretaceous Pierre Shale, Fall River County, South Dakota: *Journal of Vertebrate Paleontology*, 14 (3):35A.
- Martin, J. E. and Bjork, P. R., 1987, Gastric residues associate with a mosasaur from the Late Cretaceous (Campanian) Pierre Shale in South Dakota: In Martin, J. E. and Ostrander, G. E. (eds.) *Papers in Vertebrate Paleontology in Honor of Morton Green*, *Dakoterra*, Mus. Geol., SD School Mines 3:68-72.
- Russell, D. A., 1967, Systematics and morphology of American mosasaurs: *Bull. Peabody Mus. Nat. Hist., Yale Univ.*, 23:1-240.

## Selected Resources for Teachers

- The Illustrated Encyclopedia of Dinosaurs* by D. Norman, 1994. Crescent Books, NY, 208 p. (see especially pp. 178-180).
- Vertebrate Paleontology* by M.J. Benton, 1990. Unwin Hyman, London, 337 p.
- Vertebrate Paleontology and Evolution* by R. L. Carroll, 1988. W. H. Freeman & Co., NY, 698 p.

## Outreach (Resource Agency Personnel)

- Museum of Geology, S.D. School of Mines and Technology, 501 East St. Joseph Street, Rapid City, SD 57701 (605) 394-2467
- Badlands National Park, P.O. Box 6, Interior, SD 57750 (605) 433-5361
- U.S. Forest Service, Nebraska National Forest, 125 North Main Street, Chadron, NE 69337 (308) 432-0300

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Publication of the *Marine Reptiles* fact sheet was funded by the South Dakota Department of Game, Fish and Parks, Division of Wildlife, Pierre, SD.