v. 33, n. 1, p. 1-4
Jan. 2001

The Quest for New Dinosaurs at Grand Staircase-Escalante National Monument

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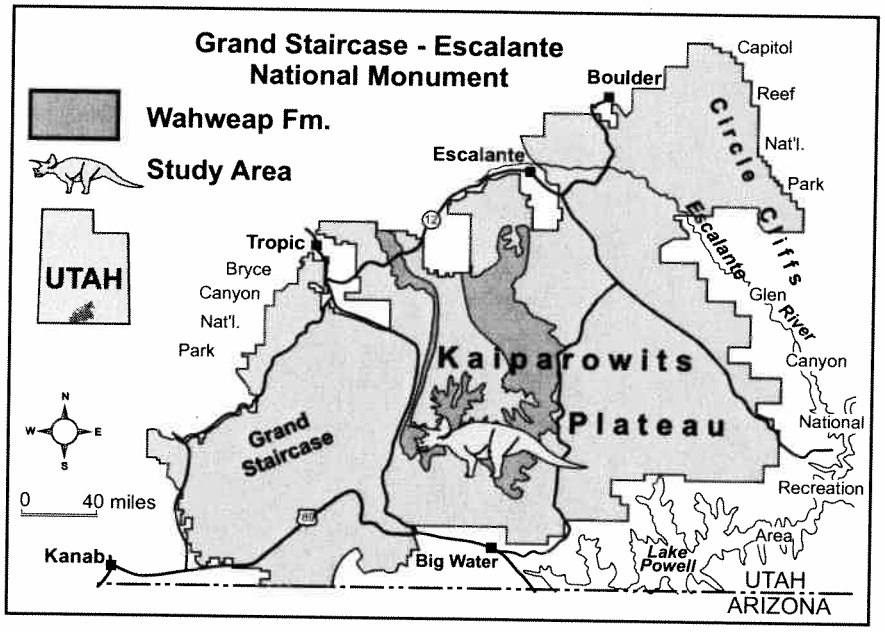
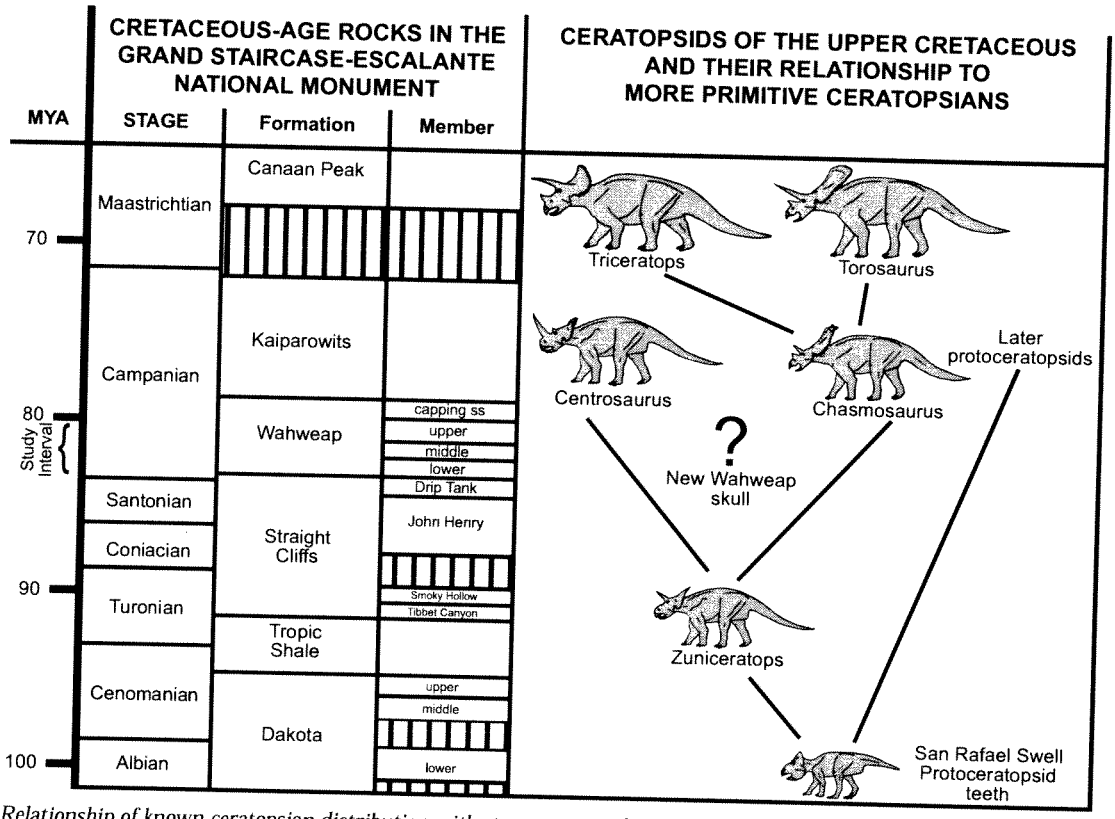
Introduction

During the past 18 years workers from several institutions (University of Colorado, Museum of Northern Arizona, Oklahoma Museum of Natural History, Utah Museum of Natural History, Utah Geological Survey, University of California at Berkeley, and Weber State University) have been conducting paleontological research within the recently designated Grand Staircase-Escalante National Monument (GSENM) in southern Utah. This research has focused on the more than 1¼ vertical miles of sedimentary rocks spanning the last 35 million years of the Cretaceous (the last period of the Mesozoic or "Age of Reptiles") exposed on the Kaiparowits Plateau. Sites have been found in each stage (a subdivision of time in a geological period) representing the Late Cretaceous in this area. This research has generated the most comprehensive and continuous Late Cretaceous fossil record of land animals known in our hemisphere, and possibly the world. In the future, this region will be the global reference for life on land for much of the Cretaceous.

This research has emphasized establishing sites preserving tiny bones and teeth (microvertebrate sites) for the purpose of identifying fossil mammal remains. Sediment containing the bone material is collected from such microvertebrate sites and washed over screens to remove the mud. Coarse material caught on the screens is then sorted under a microscope so the identifiable microscopic bones can be picked out. In this way a broad spectrum of the fish, frogs, salamanders, turtles, crocodilians, and mammals can be recognized. These microvertebrate sites can thus provide scientists with a fairly rapid view of the entire ecology of a locality. For paleontologists interested in fossil mammals, a productive microvertebrate site is considered significant even when it yields only two mammal teeth per ton processed, although most sites studied at GSENM are far more productive than that.



Dinosaurs, which represent the top large plant-eaters and meat-eaters in these changing environments, were recognized from the teeth caught in the screens, which can only be identified to the family and in a few cases subfamily level (animals are classified from general to more specific type in the following way using humans as an example; Phylum Chordata, Class Mammalia, Order Primata, Family Homidae, Genus *Homo*, Species *sapiens*). Another point to consider is that a number of dinosaur groups are toothless and thus unrecognizable in microvertebrate sites. Although several thousand dinosaur specimens have been identified throughout the thousands of feet of terrestrial (land-deposited) rocks in GSENM, only two



Relationship of known ceratopsian distribution with strata preserved at GSENM; MYA refers to millions of years ago.

dinosaurs have been found that were complete enough to identify to the genus level. In order to document the diversity of dinosaurs in these rocks at GSENM, the Utah Geological Survey, in cooperation with the University of Utah, has begun a quest for dinosaur skeletons at GSENM that can be specifically identified.

Past and ongoing field research at GSENM suggests that the Upper Cretaceous basal Wahweap Formation has particularly high potential for yielding significant new data regarding the history of life in North America. There is only one named dinosaur from the early Campanian stage (84 to 80 million years ago) of the Late Cretaceous in all of North America. Already, collections of teeth from the basal Wahweap Formation at GSENM show that these rocks in Utah preserve the greatest known diversity of dinosaurs from this age in North America. The exposures of the lower part of the Wahweap Formation paralleling the roads across the southern Kaiparowits Plateau give outstanding access and present an important opportunity to study the land animals and plants from a little-known interval of Earth history.

Skull of the Horned Dinosaur

While the UGS was conducting a paleontological survey of GSENM in 1998, a skull of a ceratopsid, or horned dinosaur, was discovered in the basal Wahweap Formation on the south end of the Kaiparowits Plateau. Triceratops is the best known of the ceratopsids, which represent a spectacular family of horned plant-eating dinosaurs that had only been recognized in Late Campanian to Latest Maastrichtian stages (80-65 million years ago) in North America. In addition to their large horns and the frill behind their heads, these dinosaurs are distinguished from their more primitive ancestors in that they have double-rooted teeth. Members of the ancestral and related dinosaur family called protoceratopsids generally lack horns and have single-rooted teeth, but they are grouped with ceratopsids into the ceratopsians based on having a beak and frill behind their head.

The newly discovered skull is the first ceratopsid specimen identified from the Wahweap Formation. Also, it is only the second undescribed ceratopsid species that has ever been found in Utah, following the 1930s description of *Torosaurus utahensis* from the latest Cretaceous North Horn Formation of the Wasatch Plateau, and it is the first new, undescribed genus. Although the skull had been exposed on the surface for several years and had broken into three major sections, it was obvious that it was an important specimen that required salvage. The Wahweap skull certainly represents a new genus as no early Campanian (84-80 million years old) ceratopsid has ever been described.

I had recently identified Utah's oldest known protoceratopsid ceratopsian on the basis of teeth from the upper Cedar Mountain Formation in the San Rafael Swell area of central Utah. Additionally, I co-described the ancestor to the ceratopsids as *Zuniceratops christopheri* from middle Turonian strata (~91 million years old) in west-central New Mexico. This animal has

Dragging large skull block on car roof to access road.

Winching the large skull block upslope.

the distinction being the oldest known ceratopsian with brow horns, but lacks double-rooted teeth. The new Wahweap fossil may provide important insights into the relationships between the ancestral ceratopsians and the better known ceratopsids of the latest Cretaceous.

In August 2000 the UGS, aided by the University of Utah, mounted an expedition to salvage the specimen. First, all the fragments of the skull had to be picked off the surface. Screening the surface guaranteed that no skull fragments were missed. Then the exposed bone surfaces were hardened with glue and encased in a plaster jacket for their safe transportation back to the UGS paleontological preparation lab. The skull sections were encased in a dense sandstone; once plastered, each block weighed hundreds of pounds.

The skull was found about one-third of a mile off an established dirt road and the excavation permit specified that no wheeled vehicle could be used to extract the massive sandstone blocks containing the skull sections. However, dragging the three blocks out to the road was allowable. For this, the roof of an old car was used as a sled. Each block was tied securely to the overturned car roof, which in turn was attached to a long rope for an eight-person team to pull the whole contraption across the landscape to the road. The largest block was pulled up a low slope by means of tow chains and a come-along. Once at the road, a chain hoist was used to lift the blocks into the truck for transport back to Salt Lake City.

In total, the process of collecting the skull took five days. The longest job still lies ahead, as it will take well over a year to remove the hard sandstone from around the bone and stabilize the skull for study. The illustration and description of the skull may take another couple of years, then Utah's newest dinosaur discovery will finally be officially identified and named.

Prospects of the Future

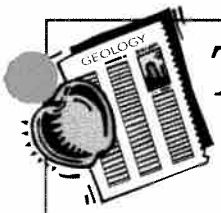
This discovery is just the first of what is expected to be a whole series of discoveries of new dinosaurs from this one thin geological interval as the UGS's research in this area continues over the next several years. Future research on the lower Wahweap Formation will include systematic prospecting for all paleontological resources within 1 to 2 miles of the access roads across the southern Kaiparowits Plateau. All fossil localities will be documented providing detailed information regarding not only the dinosaurs and other vertebrate animals, but also data about the fossil snails, clams, insects, and plants. Significant sites warranting additional research and/or excavation will be identified. A much more complete picture of what southern Utah was like during deposition of the lower Wahweap Formation will be developed from these data. Finally, this information will provide GSENM with data with which to develop specific management tools to ensure the protection and study of these fossil resources for the benefit of all.

Other geological horizons in the Wahweap and other formations in GSENM will certainly yield additional new dinosaurs as research on those geological intervals progresses. Just recently, I had the opportunity to accompany Dr. Scott Sampson and Mike Getty of the University of Utah and Doug Powell and Craig Sorenson of GSENM to examine a site near the top of the Wahweap Formation at the north end of the Kaiparowits Plateau. Here, part of the frill of an adult centrosaurine ceratopsid was found. Centrosaurines are ceratopsids with a short, ornate frill, a large nasal horn, and highly reduced horns above their eyes. This is the first fossil of a centrosaurine ever found in Utah. The future does indeed look bright for new dinosaur discoveries at GSENM.

Lower Campanian (83-79 mya, Aquilan) Dinosaurs in North America

The many indeterminate dinosaurs from the Wahweap Formation of Utah are based on tooth identifications. (Selma Chalk, Alabama (AL); Menefee Fm., New Mexico (NM); basal Two Medicine Fm., Montana (MT); Wahweap Fm., Utah (UT); and Milk River Fm., Alberta (AB); (after Kirkland, in press).

- Theropoda
  - Dromaeosauridae
    - Indet. dromaeosaurine (UT, AB)
    - Indet. veloceraptorine (UT)
  - Troodontidae
    - Indet. (UT)
  - Ornithomimidae
    - Indet. (AB)
  - Tyrannosauridae
    - Indet. aublysodontine (UT)
    - Indet. tyrannosaurine (UT, NM, AB)
      - cf. *Albertosaurus* sp. (AL)
  - Indeterminate Family
    - cf. *Richardoestesia* sp. (UT)
    - cf. *Paronychodon* sp. (UT, AB)
- Ankylosauria
  - Nodosauridae
    - Indet. (UT, AL, AB)
  - Ankylosauridae?
    - Indet. (UT, NM)
- Ornithopoda
  - Hypsilophodontidae
    - Indet. (UT)
  - Hadrosauridae
    - Hadrosaurinae
      - *Gryposaurus latidens* Horner, 1995 (MT)
      - Indet. (NM, UT, AB)
    - Lambeosaurinae
      - Indet. (UT)
- Pachycephalosauria
  - Indet. (UT)
- Ceratopsia
  - Protoceratopsidae
    - cf. *Montanaceratops* new genus and sp. (MT)
  - Ceratopsidae
    - New genus and species "unprepared" (UT)
    - Indet. (AB)
  - Centrosaurinae
    - Indet. (NM)



Teacher's Corner

NEW! Teaching Packets for your Classroom

The UGS is developing teaching packets that you will be able to check out with a refundable deposit. The first available is the "Earthquake Teaching Packet." Other topics being considered include soils for K-6, guides to rock and minerals, Great Salt Lake, local geology, and volcanoes.

Now available! ***Earthquake Teaching Packet*** contains slides, activities, and more:

- *A Teacher's Handbook on the Earthquake Hazard in Utah*, 1992, created for grades 7-12. In addition to 28 pages of text, the handbook contains diagrams, figures, tables, glossary, 6 activities, and 30 slides with descriptive captions.
- *Earthquake Awareness & Risk Reduction in Utah*, 1991, 24-minute video developed by Utah State University. Explains and illustrates the different ways earthquakes can cause damage, and discusses what can be done to minimize damage.
- *Earthquakes & Utah*, 1997, 8-page brochure answers the questions of where, why, and how often earthquakes occur in Utah; how big they are and how they are measured; and what may happen during an earthquake.
- *The Wasatch Fault*, 1996, 18-page brochure with photos, diagrams, and explanations.
- *Homebuyer's Guide to Earthquake Hazards in Utah*, 1996, 27-page pamphlet describes and illustrates the hazards of ground shaking, liquefaction, fault rupture, slope failure, and flooding.
- *Earthquakes - What You Should Know When Living in Utah*, 22 pages of important information from the Utah Division of Comprehensive Emergency Management.
- *Earthquake Ground Shaking in Utah*, 1994, 4-page pamphlet.
- *Earthquake Hazards & Safety in Utah*, 1990, 4-page pamphlet.

Materials in this packet are appropriate for grades 5-12, with the majority most applicable for grades 7-12.* Call 801-537-3300 to reserve the kit, which must be picked up and returned to our office at 1594 W. North Temple, Salt Lake City. A $25.00 refundable deposit is required.

While you are at our office, you can also pick up several related items (for free!) to use and keep in your classroom (ask Geologic Extension Service staff):

- a colorful poster of a block diagram of the Wasatch fault
- fault block models
- liquefaction-potential maps of Box Elder, Weber, Davis, Salt Lake, and Utah Counties
- fault maps of Box Elder, Weber, Davis, Salt Lake, or Utah Counties

** contact Sandy Eldredge for suggestions for K-6 earthquake-teaching materials.*

WE WANT YOUR FEEDBACK!
Please contact us with specific requests or ideas for packets that woud be of help to your grade level. Contact Sandy Eldredge at 801-537-3325, 801-537-3400 (fax), nrugs.seldredg@state.ut.us