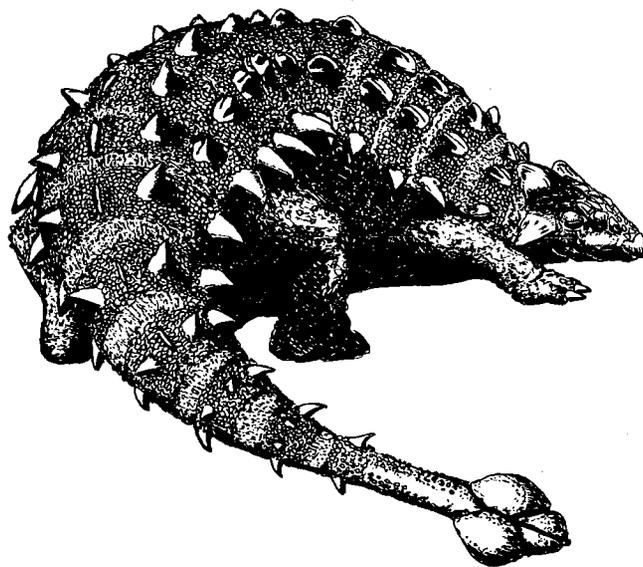

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The Iren Dabasu Fauna from Mongolia

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EVERY DINOSAUR ENTHUSIAST has heard at one time or another about the famous American Museum of Natural History expeditions to Mongolia in the 1920s. Their most famous find, of course, was the small dinosaur *Protoceratops* and its clutch of eggs. Lost in the glory and not well publicized was the fauna in the formation underlying it, called the Iren Dabasu fauna. Several unreported species of dinosaurs in the fauna may make it the largest collection of dinosaur babies known to science. Not only is this fauna more important scientifically than the Djadochta, but its history reads like a detective story, and the mystery of why these species went unreported dates back to 1933.

Although *Protoceratops* of the Djadochta Formation has been popularized in numerous reports and "coffee-table" books, only one full scientific paper to date has appeared on the Iren Dabasu fauna, the original one in 1933 by Charles W. Gilmore of the U. S. National Museum, a part of the Smithsonian Institution. As with any fauna, the scientific story of its analysis must be considered in the light of the times when it was made, as well as who did the study and how it was done. The manner of collection and who described it are sometimes, in paleontology, as important as the scientific work itself.

Back in the 1920s, the American Museum sent many people to Mongolia to collect specimens of fossil vertebrates. Many of these people were geologists and mammalian paleontologists, but none was a dinosaur specialist. When the dinosaurs were collected, there were no specialists at the quarries familiar with the anatomy of the animals they were digging up. The standard procedure in cases like this was to collect the specimens, send them back to the museum, and have technicians prepare them. Then the experts would work on them in their offices.

In Mongolia, American Museum geologists and paleontologists, along with local labor, opened up two quarries six miles away from an isolated telegraph station in the desert. They collected the specimens, gave them field numbers which did not conform to the animals in the quarries, and sent them back to New York. The field numbers probably referred to quarry locations or shipment numbers. This was later to cause a great deal of confusion.

Once the specimens were back in New York, they were prepared and given to Barnum Brown for study. Brown, the world's greatest dinosaur field man and collector, unfortunately had missed the Mongolian trip due to field work elsewhere. He worked on the animals and even went so far as to give names to them, but he mysteriously dropped the project and left it uncompleted. The material was then sent to Gilmore at the Smithsonian. He was one of the world's leading authorities on dinosaurs at the time, and was a better comparative anatomist as well. Gilmore had never been to Mongolia, so all he had to work with were the notes made by the field crews. At this time, the Smithsonian did not have a large dinosaur collection, which meant that the comparative anatomy aspects of the study would be based on inadequate material. The largest collections of dinosaurs in the world were at the American Museum, the Carnegie Museum in Pittsburgh, and the Yale Peabody Museum in New Haven. It is not known whether Gilmore actually went to these places to compare his bones; but it is apparent from his other published papers that he relied heavily on the literature for information about other dinosaur remains. This did not stop him from publishing superior works of paleontology that are still models today.

Gilmore described members of four families of dinosaurs from the formation, and he also noted the presence of crocodiles, turtles, and fish. The four families are: (1) the Ornithomimidae, or "ostrich dinosaurs"; (2) the Deinodontidae, now called the Tyrannosauridae (after "you know who"); (3) the Nodosauridae, one of the families of armored dinosaurs; and (4) the Hadrosauridae, or duckbill dinosaurs. The nodosaur material was very sparse, consisting of an ilium (hip bone). Gilmore wisely chose not to name new species based on such poor material. The deinodont material consisted of many parts of a skeleton, including bones of the upper arm, hand, shin, and foot. It was placed in the Deinodontidae because it was big and unlike any other Asian meat-eating dinosaur at the time. It was called *Alectrosaurus* ("unmarried lizard"). The ornithomimid material was not as good and was almost identical to *Ornithomimus* of North America. Since both theropod species occurred in Asia and were unlike any other

known Asian species, they were given new names. Back then, it was considered acceptable practice to name a new animal if there were no other animals like it at the same time and place, regardless of what other animals existed at the same time in different places. This was before the now-accepted theory of continental drift. We now know that eastern Asia and western North America formed *one* biogeographic province called *Beringia* (after the connecting land mass across the Bering Strait; Figure 1). It may be shown one day that the species that Gilmore named are actually identical to previously named North American carnivorous dinosaurs that coexisted with them in Beringia.

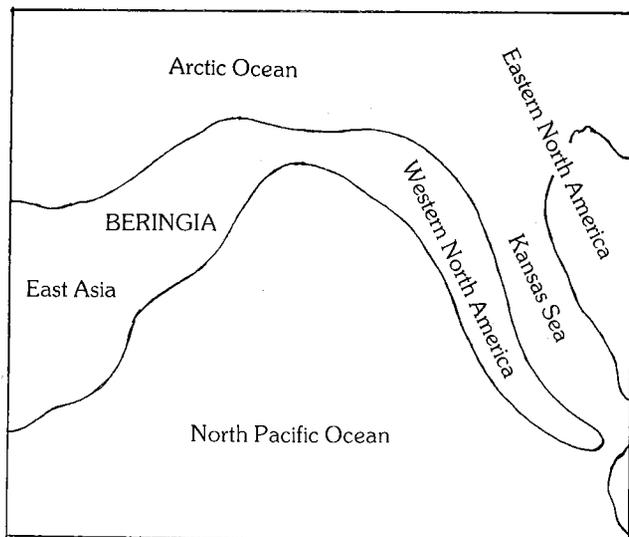


Figure 1. During much of Iren Dabasu time, eastern Asia and western North America were connected by a land bridge located where the Bering Strait is today. This combined biogeographic province is called Beringia.

The true scientific value of this fauna lies in the duckbill dinosaurs. In the Iren Dabasu are the ancestors of the two duckbill subfamilies, the Hadrosaurinae, flat-headed forms like *Edmontosaurus* (incorrectly called *Trachodon* and *Anatosaurus*), and the Lambeosaurinae, forms with crested heads like the famous *Corythosaurus* and *Parasaurolophus*. Gilmore named two species which may be considered the missing links between the iguanodont ancestors of the duckbills and the more advanced forms so familiar in popular books.

The fauna itself was dated lower Upper Cretaceous; it lies at the base of the Upper Cretaceous time period, about 90-100 million years ago. This was done by dating the rocks according to the morphological complexity of the animals in the formation. The more "morphologically advanced" the animals, the younger are the rocks relative

to other formations with "less advanced" animals. A favorite saying of paleontologists is, "You date the rocks by the fossils, and the fossils by the rocks." There is no exception here.

This fauna also is similar to the fauna from a place called the Two Medicine Formation in Montana. This is not unreasonable, as both faunas were on the same land mass back then. Both the Two Medicine Formation (now being studied by John R. Horner of Princeton University) and the Iren Dabasu Formation have unusually large numbers of juvenile dinosaurs. This is extremely rare in paleontology. There also seem to be some nest sites where baby dinosaurs were protected by their parents or "baby sitters." This again is most unusual in reptiles. It is noteworthy that there are very few predacious crocodile and fish remains in the quarries, but there are many small carnivorous dinosaur remains. It is likely that the nests were well away from rivers, and any crocodiles in the area were outcompeted by the faster meat-eating theropod dinosaurs.

The two new duckbills named by Gilmore were *Mandschurosaurus* (now called *Gilmoreosaurus*), ancestral to the Hadrosaurinae, and *Bactrosaurus*, ancestral to the Lambeosaurinae. *Gilmoreosaurus* was redefined and renamed (after Gilmore) as part of a recently completed revision of the entire duckbill family. It shows the early trends from the Iguanodontidae to the Hadrosaurinae. The skeleton is lighter and more gracile. The arms and hands are relatively longer and so are the distal parts of the legs, making it a better running biped. The bone structures indicating muscle attachments demonstrate that these duckbills had much greater strength in their legs, for quicker acceleration. And major changes occur in the skull. Iguanodonts (like *Iguanodon*) have only one row of teeth, and the teeth are few in number. In *Gilmoreosaurus* there are multiple rows of teeth and each row has relatively more teeth in it. The teeth are interlocking, wear evenly, and were continually replaced as they wore out, insuring that there was a continuous dental pavement to grind up plants. These animals always had a complete set of teeth throughout their lives.

The other duckbill, *Bactrosaurus*, represents the group ancestral to the crested forms. It is more massive and heavy than *Gilmoreosaurus* and was definitely a more powerful herbivore. The jaws were relatively shorter and the jaw muscles relatively longer, making the jaw a more powerful and efficient grinder. It ate more fibrous plants than the hadrosaurines did, and probably lived in an area where there were more theropods.

The origin of the duckbills took place at a time when the angiosperms, or flowering plants, were undergoing their radiation. The evolution of the duckbills, and the ceratopsians (horned dinosaurs) as well, was probably a response to this new and abundant food supply. It is

thought that the duckbills specialized in consuming "soft fiber" foods like leaves, twigs, fruits, and so forth, while the horned dinosaurs, with their *slicing* dental pavements (like giant scissors), specialized on "hard fiber" material like elephants do today.

Both duckbills were found quite close together, but *Gilmoreosaurus* was found only in one quarry, while *Bactrosaurus* was found only in the other quarry. This is to be expected if these places were truly nest sites, since closely related species rarely nest in the *exact* same areas because of competition for food sources. The age groupings also indicate that the area might have been a nest site. There were many dinosaurs of the hatchling size. There was another group, fewer in number, which can be called the "teenage size." And finally there were only one or two adults. This is also true in the Two Medicine fauna, where, in 1978-79, the Princeton expeditions found intact nest sites apparently guarded by a "mother hen" (the hadrosaur was named *Maiasaura* in honor of this supposition). I believe this shows that the duckbills did not reproduce continuously like humans, but had definite breeding seasons, and that the juveniles grew up in their own age sets.

Because scientists do not yet know the rate at which these animals grew, nor the life span of an individual, it is hard to say how long it took these dinosaurs to reach adulthood. It may be that they all reproduced yearly and the juveniles grew exceptionally fast, or that only some of the individuals reproduced at any given time, and they grew up more slowly. If there were so many helpless babies running amok, where were the theropods to take

advantage of these "animated hamburgers"? Gilmore only reported two large species of theropods. Where were the medium-sized and small carnivores? This brings us to the mystery I mentioned earlier.

Apparently the field numbers refer to localities rather than to animals. *Bactrosaurus* largely falls under the field number 141, while *Gilmoreosaurus* mainly comes under field number 149. Many other elements also have these field numbers, including several boxes of small bones representing many species. I estimate that there are at least 100 unidentified bones. Gilmore realized this too, because he stated that this troubled him. This could very well be the reason he only worked with the adults. They were few in number and more easily compared to other dinosaurs known from complete skeletons. This, however, left almost the entire juvenile fauna undescribed and unanalyzed. This study is presently being undertaken by John R. Horner and myself (we are working separately on different aspects). One of the first finds to date is that there may be as many as four carnivores instead of only the two named by Gilmore. Three of the carnivores can easily be told apart by their claws, which range in form from long and slender in some specimens, to short with a wicked curve in others (as in the famous *Deinonychus*). Because nest sites of many species grouped together would be such a tempting target, the carnivorous dinosaurs would be drawn there like a magnet. There may also be more herbivores in the fauna. After all the bones are identified, the number of species in the fauna could double or triple.

The sharing of nest sites by populations or species has

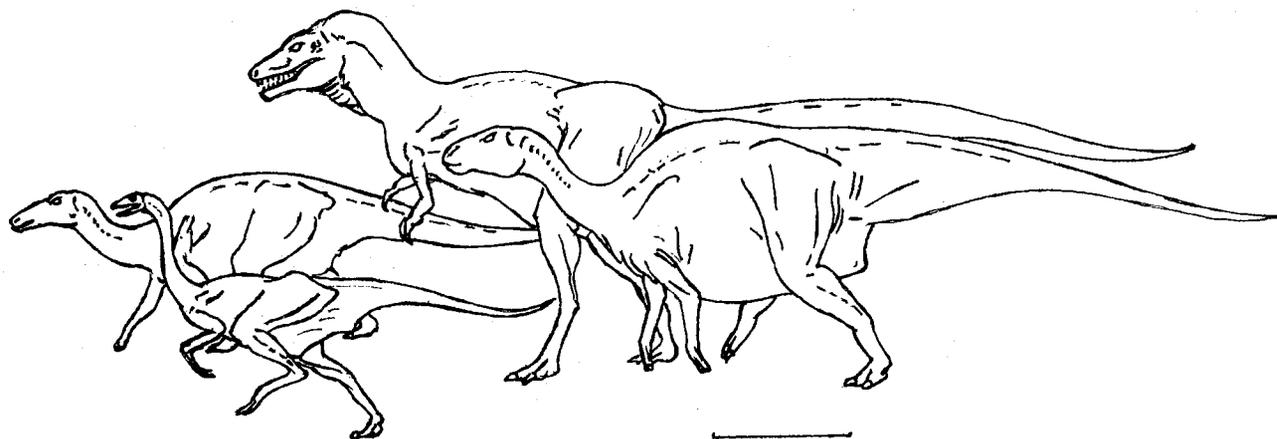


Figure 2. Gilmore's dinosaurs from Iren Dabasu. Left to right: *Gilmoreosaurus* (formerly *Mandschurosaurus*) *mongoliensis*, *Archaeornithomimus* (formerly *Ornithomimus*) *asiaticus*, *Alectrosaurus* *olseni*, and *Bactrosaurus* *johnsoni*. Scale equals 1 meter. Chart by George Olshevsky, after Gregory Paul. All these dinosaur reconstructions are somewhat hypothetical, because the material is more or less incomplete.

an advantage in communal protection and also frees more females to search for food, so that only a few need remain behind as "babysitters." This is also indicated in part by a study of *Protoceratops*. Dr. Nicholas Hotton stated in 1963 that a single *Protoceratops* could not have laid all the eggs found in one nest; the total volume of the eggs in one nest exceeds that of a complete adult individual! It is therefore believed that many females laid their eggs together in a communal nest. We can extend this concept a taxonomic order of magnitude to the species level: Several species of herbivores nesting in one area would need proportionally fewer guardians. The warning call of one guard would serve to alert all the other species. This operates today on the African Serengeti Plains, where many herbivores congregate to feed. Some rely on sight to spot predators, while others rely on the sense of smell. This "division of labor" makes their early warning network highly effective.

Many ecological studies show that the number of carnivorous species that a fauna can support is related to the size of the prey items. It is appropriate to view the carnivores as representing small, medium, and large size classes, like the jackal, the cheetah, and the lion. Each predator will take prey only in certain size ranges. For example, lions do not chase birds, and jackals do not chase wildebeest. It is conceivable that some theropods

hunted in packs while others were solitary hunters or scavengers. It has already been proposed by some paleontologists that the medium-sized theropods like *Deinonychus* were pack hunters, while super-large predators like *Tyrannosaurus* may have been scavengers because they were too big and slow to catch live prey!

The field of dinosaur paleoecology is just opening up, and much more work remains to be done. One of the benefits so far has been to show that such efficient use of nests indicates a degree of intelligence in dinosaurs that exceeds that of all other reptiles. As dinosaurs were ancestral to birds, this is not entirely unexpected. In the past, it has been traditional to study dinosaurs one species at a time and usually only in a descriptive sense. By analyzing dinosaurs as functioning biological machines within ecological systems, we will one day have a knowledge of past life comparable to our knowledge of many present animals, at least on the level of populations. All species are part of living communities, and it is the job of the paleontologist to show how each species related to the other species in the web of life.

Although no more expeditions are possible to Mongolia at this time, light will be shed on the natural history of dinosaurs by further scientific expeditions to the basement of the American Museum of Natural History. ★