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DINOSAURIA IN THE RED BEDS OF MIDDLE ASIA (EAST
TURKESTAN)*

The remains of dinosaurs that were found near the city of Tashkent did not prove to be as valuable as geologists and paleontologists had hoped them to be, and did not give any new information about the Upper Cretaceous beds of Turkestan. The exact constitution of the Tashkent fauna could not be determined because of the very fragmentary condition of the material obtained, on account of the great interest created by the news of the discovery of the bones of dinosaurs in East Turkestan, in the basins of the rivers Ili and Chu. The Iliyskay expedition of the Academy of Sciences was sent in 1927 with special instructions to acquire the remains of dinosaurs. The excavations were made at two points in the Ili Valley: Kara-cheku and Kalkan, and only small fragmentary material was found, material which was without any real value for scientific research. The quality of material of the East Turkestan localities happens to be even worse than those discovered near Tashkent.

In 1929, soon after the statement of Sven Hedin and the discovery of complete skeletons of dinosaurs in Chinese Mongolia, the Geological Museum of the Academy of Sciences of the U.S.S.R. sent me to Eastern Turkestan for preliminary investigations of the recently discovered dinosaur localities. The principal point of it was to find in the red-colored series some other facies that better preserved the remains of dinosaurs. During two months I covered a tremendous distance — Almata — Iliyskoe — Dzharkent — Achinokho — Karkara — Rybach'e — Frunze, and investigated the principal points of the development of the red-colored Tr^t and Cr^t series of the Iliyskoy plain, Ketmenskoy Range, Karkara-Kegensky plain, and the shore of Issyk-kulya Lake.

Of course only a few preliminary investigations could be made in such a great territory in such a short time.

The localities known at the present time are in the plains of the rivers Ili (Kalkan, Karoy, Kara-cheku) and Chu (Kok-Maynak). A very short time ago the Geol. Institute

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Cartogr. Geol.-Devel. Upr. geologist D. I. Yakovtev discovered thick bone-bearing layers in the lower courses of the river Chu, and in the southeastern part of Bek-Pak-Daly.

All these localities are very similar in the kinds of material they are composed of, in the type of succession and the preservation of the remains of dinosaurs, and probably belong to the same stratigraphic horizon — the lower part of the Tr¹ series.

The bone-bearing layer consists of a lens-like disorderly laid conglomerate. In some places there are small intercalated layers of mica-containing sands (Kalkan, Kara-cheku). Conglomerates consist for the most part of well-rounded pebbles cemented with gypsiferous sand.

The black conglomerate layer is found in the Kara-cheku locality. Here is noticed a very high concentration of iron in bones, and fragments of tree stumps that contain up to 60% iron. In the red conglomerates are dense and fragile bones of a rose color. The basic mass is gypsum (CaSO₄). A small quantity of flint is contained in it, and in the Kara-cheku locality there is a small quantity of iron. The calcium carbonates, so common with the usual conservation of bones, are absent. The usual in such cases cemented crustal layer around the bones is absent, but a very thin, secondarily deposited gypsum crust is constantly present.

Bones are broken, rounded, and very badly worn. In the rich collection of the Iliyskoy expedition of 1927 there is not a single well-preserved bone. The shafts of limb bones are the greatest in number. This is explained by their being the most massive part on the bone. Epiphyses are very worn, sometimes having their spongy parts absolutely destroyed. The edges of the broken pieces are rounded and worn. Besides that the fragile bones have cracks that are filled with the same gypsum. There is no definite rule about the position of bones in the layer. The remains of entirely different representatives of the group of *Dinosauria* are intermixed in a disorderly manner within the conglomerate. In all of the localities of this type the possibility of finding not only the whole skeleton, but even of two unbroken bones of the same animal, is absolutely rejected.

Such a poor state of preservation does not permit the exact identification of bones. The largest number of remains belong to *Ceratopsidae*, *Stegosauridae*; also *Trachodontidae* and small dinosaurs of the group *Ornithomimidae* (identification by A. P. Gartman-Veynberg). Among the bones of dinosaurs often are found the rounded pieces of turtle shell. The stumps of trees are met more rarely than in the Tashkent locality. Absolutely absent are *Invertebrata*, and because of that the age of the layer is questionable.

Genesis of the described localities is quite complex. The continental character of the red-colored Tr¹ series is very much like the continental layers of floodplain type. But the bone-bearing conglomerate layers, consisting of the well-mixed rounded pebbles with sand and without a sharp-edge-pieces of material, are more like the layers from along the shores of the big basin. The great roundness of the bones also supports this supposition. But the process of rounding the bones, infiltrating them with iron and gypsum, must have taken place in the closed basin, with quiet water and with a concentration of the salts of above-mentioned minerals.

The whole character of layers where dinosaurs were found, the absence of the crust around the bones, the state and the disorder of the bones in the layer, also do not agree with the demands of lithification. The breaks of the big limb bones in a non-mineralized condition needed quickness and the strength of the sediment-carrying stream,

and this is opposite to the petrographic composition of the layers. On the other hand, during the washing over of the bone-bearing layers after lithification, bones could have been broken without any mechanical strain, just by atmospheric reagents.

Thus there must have been two stages of the development of the East Turkestan localities — conservation and overlaying of the old layers. Of the known dinosaur localities the most typical are: Mongolia, the Missouri plain in the North American United States, and Tendaguru in East Africa. Very fragile but of very good preservation, the skeletons of Mongolian dinosaurs are found in layers, sometimes in the layers of very short-lived basins. The tremendous numbers of dinosaur skeletons in North America are probably the result of disposition during the wide flooding of the land with extensive water basins. Finally the localities of the gigantic *Atlantosauridae* in Tendaguru — thick layers of marl with a marine fauna, with in-layers of sand, were formed on the low boggy shore of the quiet bay of a shallow sea.

For all of these localities there is one common characteristic formation of a thin homogenous material, which was done in the quiet basins, thus guaranteeing the preservation of bones, although they could be partly destroyed by atmospheric reagents. The opposite action — the dinosaur localities in East Turkestan. Having a tremendous collection of bones, we cannot find a single one well preserved. The invertebrate fauna and the flora, with the exception of a number of unidentified pieces of trees, is absent. It is impossible to suppose that such collections of dinosaurs were the result of the work of water of a big basin which carried the remains of land animals from all over the continent to these places. If such was the process, one more factor would be necessary, but such could not be in the conditions of part-time continental streams or in the great water basins.

The end of the Cretaceous Period was the time of the migration of large land dinosaurs as a result of increased changes in the physico-geographic conditions. And also was notable for the beginning of the dying out of these animals.

The route of migration was probably from the Dzhungarskogo [Mongolia] continental massif in western Turkestan along the edge of the Upper Cretaceous sea, where dinosaurs could get their food more easily, rather than in the stony and desert-like plain of the peneplained Paleozoic continent. Even at the present time, we may observe the mass formation of quicksands, in the conditions of the rocky next to the sea shore and with the sandy shore. Such are the quicksands of the Zaussuriyskogo district. During the Upper Cretaceous age in East Turkestan some factors must have guaranteed the mass collection and conservation of the remains of dinosaurs. During their search for food on the low shore of a sea, whole herds of dinosaurs were buried in the quicksands. The constant migrations added new masses of bones. Small epeirogenic movements called for the retreat of the sea with energetic evaporation in small, remnant lagoons and mineralization of dinosaur bones, or the gradual advance on the sea, washing out and rounding the old layers and forming the pebbles that were laid down by the preceding cycle of formation.

Finally during the Tertiary age happens the new energetic raising of the platform of erosion. All of the layers were energetically washed off and were carried by freshet-type streams. Then the thick clay layers, in some places containing gypsum and the others salt. The bones of dinosaurs were washed over again, and were finally buried broken, rounded, and intermixed. All that remained of the past formation were small

islands, which were saved because of their very close contact with the stable Paleozoic massif. The evidence from the layers in the Kara-cheku locality supports this supposition.

Thus, with sureness it can be concluded that all of the attempts to find whole skeletons in the above-mentioned localities will end in failure. The explorations must be put on in a different way — after explorations of the conditions of the localities, the search for the preserved remains of Cretaceous bone-bearing strata must be made. It is possible that among the layers of these strata it will be possible to find the islands of the conserved basins of the continent, where will be dinosaurs, although not in great numbers but preserved well enough for scientific work.

The great Eastern route of migration we know. Now we must find dinosaurs on this route.

[Summary in English follows.]