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THREE NEW THEROPODA, PROTOCERATOPS ZONE, CENTRAL MONGOLIA¹

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In 1923, in the red Djadochta sandstone at Shabarakh Usu, were discovered three remarkable new types of small dinosaurs related to the Theropoda. All three types are approximately of the same geologic age, namely, the life zone which we now regard as near the beginning of Upper Cretaceous time. The skulls are entirely dissimilar and extraordinarily interesting.

The first (Fig. 1) of the typical megalosaurian type, although of small size, seems to have been an alert, swift-moving carnivorous dinosaur to which the generic name *Velociraptor* is applied.

The second (Figs. 3, 4), although megalosaurian and provided with a row of teeth, was at first mistaken for the skull of a bird, owing to its long slender rostrum; it may prove to have avian relationships; hence we name it *Saurornithoides*, the "birdlike theropod."

The third (Figs. 6, 7) is a short skull, entirely toothless like the Ornithomimidæ, which was found lying directly over a nest of dinosaur eggs, separated only by four inches of friable sandstone; hence we name it *Oviraptor*, the "egg seizer." The fore limb found with this skull is clearly related to the Ornithomimidæ.

The actual proportions of these three skulls are well displayed in the accompanying figures (Figs. 1, 3, 6 and 7) to a one-half scale.

***Velociraptor mongoliensis*, new genus and species**

TYPE.—Amer. Mus. 6515, skull and jaws, one front claw and adjoining phalanges. Djadochta beds at Shabarakh Usu, August 11, 1923, Field No. 377, collector P. C. Kaisen.

GENERIC CHARACTERS.—Skull and jaws of diminutive megalosaurian type. Cranium abbreviated; orbits greatly enlarged; face elongated; four fenestræ in the side of the cranium, one fenestra in the jaw. Teeth recurved, serrate on one or both borders, alternating in replacement; 3 ? + in premaxillaries, 9 ? + in maxillaries, 14 in dentaries.

¹Publications of the Asiatic Expeditions of The American Museum of Natural History. Contribution No. 32.

SPECIFIC CHARACTERS.—Ungual phalanges very large, laterally compressed, strongly recurved, super-raptorial in type.

This skull was found in the soft sandstone matrix lying alongside a skull of *Protoceratops andrewsi*. Although slender and diminutive, it is none the less of typical megalosaurian or theropod type, suggesting a family relationship to the Megalosauridæ. The ten or twelve sharply recurved teeth are strongly serrate on the posterior border, less serrate on the anterior; thirteen to fourteen in number in each jaw, somewhat homodont or similar in form, although differing in size, recurvature and serration; irregular or alternating in replacement, so that the wide gaps between the recurved crowns are perfectly adapted to the sudden seizure of light and swift-moving prey; sharply compressed, strongly recurved phalanges facilitating the holding of the prey; the long rostrum and wide gape of the jaws indicate that the prey was not only living but of considerable size.

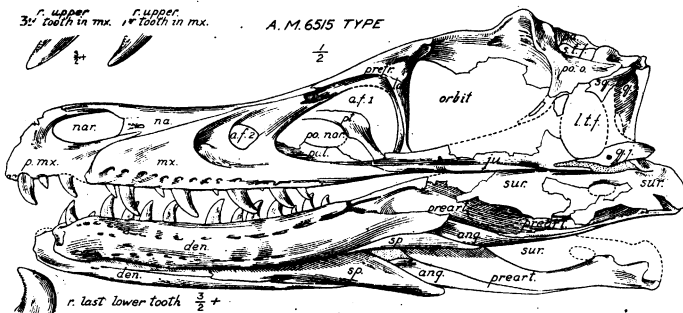


Fig. 1. Type skull and jaws of *Velociraptor mongoliensis* (Amer. Mus. 6515). From the Djadochta formation, Protoceratops zone, central Mongolia. One-half natural size. Enlarged maxillary and mandibular teeth: (Above) first tooth in maxilla, double serration; third tooth in maxilla, single serration. (Below) posterior tooth in dentary, single serration. $\frac{3}{2} +$ natural size.

MEASUREMENTS

Skull, length over all, occiput to premaxillaries.....	176 mm., est.
Facial length, anterior border of orbits to premaxillaries.....	111
Cranial length, anterior border of orbits to occiput.....	65
Faciocranial index.....	170%
Mandibular length, tip of dentaries to back of surangular.....	175

These measurements indicate that the face is relatively much longer (index 1.70) than the cranium, that the postorbital region of the cranium is extremely abbreviated, that the jaws are excessively long and slender. The post-temporal region is of the typical diapsid type with two fenestrae, supratemporal (s.t.f.) and laterotemporal (l.t.f.). There is a

very large antorbital fenestra (a.f.1) and a smaller antorbital fenestra (a.f.2). With the aid of Prof. W. K. Gregory, the following cranial elements have been made out: quadrate, quadratojugal, squamosal, parietal, postorbital, jugal, prefrontal, lachrymal, palatine, nasal, maxillary, premaxillary; in the jaw, surangular, prearticular, angular, splenial, dentary.

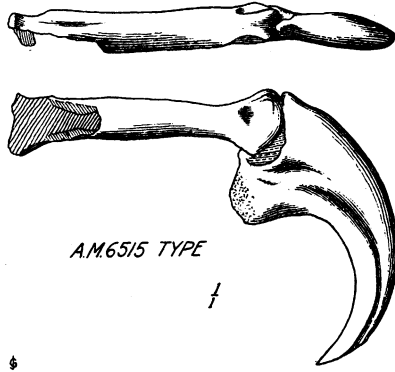


Fig. 2. Phalanges of *Velociraptor mongoliensis* associated with type skull and jaws (Amer. Mus. 6515). Natural size.

By comparison with *Allosaurus* (cf. Gilmore, 1915), these phalanges probably belong to the enlarged Digit I of the manus, namely, 1 ph., 2 ph. (Upper) viewed from above. (Lower) viewed from the side.

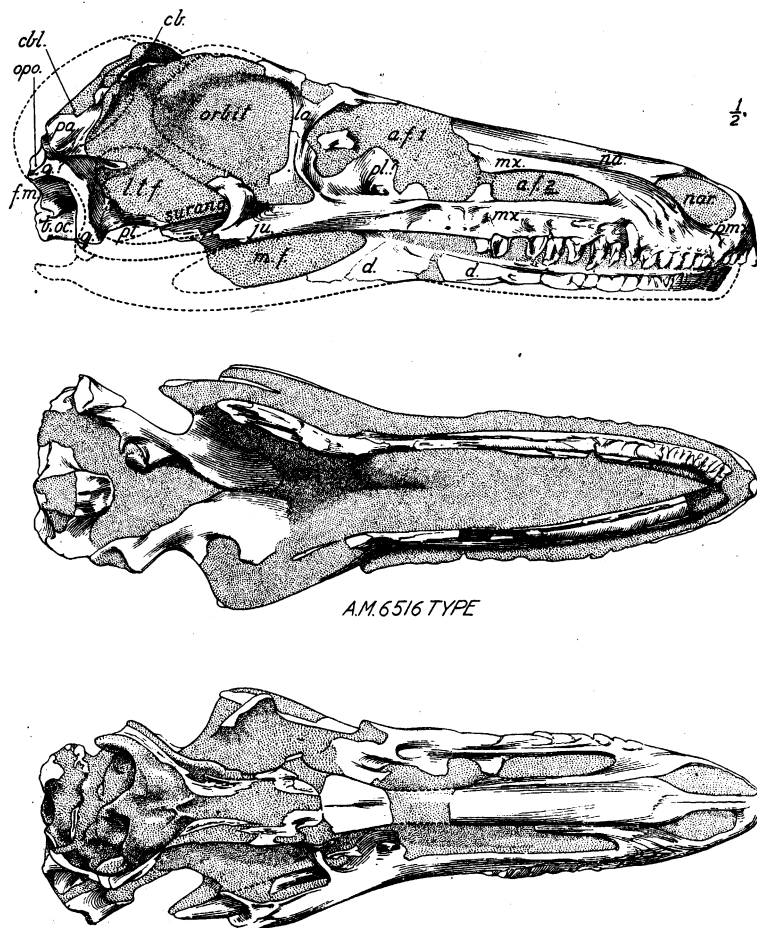
***Saurornithoides mongoliensis*, new genus and species**

TYPE.—Amer. Mus. 6516, skull and jaws found in a concretion lying on the surface with bone and teeth exposed and much weatherworn; nearby in another concretion a series of vertebræ with pelvis, parts of hind limb and pes which may belong to the same individual as the skull. Collected by the Chinese assistant, Chih, July 9, 1923, Field No. 256, Djadochta beds at Shabarakh Usu.

GENERIC CHARACTERS.—A diapsid and probably theropod reptile with five craniofacial fenestrations and one mandibular fenestration; nineteen maxillo-premaxillary teeth, practically homodont, fairly uniform in dental replacement; not of active raptorial type; teeth serrate only on posterior borders.

SPECIFIC CHARACTERS.—Teeth flattened, serrate on posterior borders only, diminishing in size from the first to the fourth premaxillary tooth, increasing in size from the first to the tenth maxillary tooth; uniform in replacement, closely compacted below; crowns recurved, subacutely pointed.

When first discovered, the type skull (Fig. 3) was partly covered with sand and largely worn by the action of the drifting sand. Its long pointed rostrum strongly suggested the skull of one of the toothed birds, but it has since proved to be on the reptilian or megalosaurian side. The name *Saurornithoides* is assigned, signifying the "saurian with birdlike rostrum." For avian character, one naturally examines the quadrate



A.M. 6516 TYPE

Fig. 3. Type cranium and jaws of *Saurornithoides mongoliensis* (Amer. Mus. 6516), *Protoceratops andrewsi* zone, Djadochta formation, collection of 1923. All figures one-half natural size.

(Upper) right lateral view of cranium and jaws as embedded in the Djadochta sandstone indicated by dots.

(Middle) palatal view of cranium, showing inferior view of dentaries, palatines, pterygoids, posterior nares and basioccipitals.

(Lower) top view of cranium as embedded in the sandstone. The walls of the brain case, including the cerebrum and cerebellum region, are clearly indicated.

which appears to have movable articular surfaces with the parietal above and quadratojugal below; but this point awaits confirmation. The fenestration of the skull is of the diapsid type, resembling in its five openings on each side the typical megalosaurian *Velociraptor* described above, namely, the supratemporal, laterotemporal (l.t.f.), antorbital

(a.f.1), second antorbital (a.f.2), narial (nar.); it has also apparently a large mandibular fenestra (m.f.) behind the dentaries. With the exception of the fairly free borders of the quadrate (q.), the bony sutures seem to be chiefly closed and the following elements are made out mainly by their anatomical position: parietal (pa.), quadrate (q.), basioccipital (b.oc.), pterygoid (pt.), jugal (ju.), lachrymal (la.), palatine (pl.?), maxillaries (mx.), premaxillaries (pmx.), dentaries (d.). Above the parietals is observed an imperfect cast of the cerebrum (cb.) and of the cerebellum (cbl.).

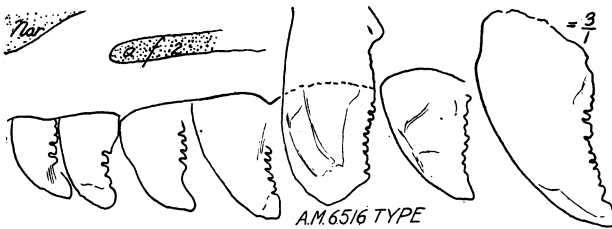


Fig. 4. Diagram of seven anterior maxillary teeth of the left side of *Saurornithoides mongoliensis* type, beneath the anterior nares (nar.) and the antorbital fenestra (a.f.2), showing deep serrations on the posterior border. Three times natural size.

DENTITION.—The teeth are subhomodont or of similar shape but differ widely from those of *Velociraptor* in their uniform replacement, the summits of the fifteen crowns of the maxillary teeth being approximately on the same level. It is difficult to determine the exact number or characters of the teeth, owing to the severe attrition of the dental series. There are apparently four premaxillary and fifteen maxillary teeth, nineteen superior teeth in all. This indicates that *Saurornithoides* had different feeding habits from *Velociraptor*; it was less adapted to seizing alert, swift-moving prey; it may possibly have been an egg feeder, namely, ovivorous. We must await the evidence afforded by the limbs.

The inferior view of the skull apparently displays the surface of the partly damaged jaws, the dentaries and the wide closure of the posterior nares by the union of the pterygoid plates. The backward extension of the posterior nares and the union of the pterygoid are frequently an adaptation to aquatic life; it is possible, therefore, that *Saurornithoides* may have had an aquatic habitat, a point to which the limbs might bear testimony. The fragment of hind limb and left pes (Fig. 5) found in a concretion near the type skull is of cursorial and raptorial type. Although much fractured and weathered, the four digits exhibit the following characters: D.I, 2 ph., partly compressed; D.II, 3 ph., partly compressed; terminal claw 30 mm., recurved; D.III enlarged, 3+ ph.,

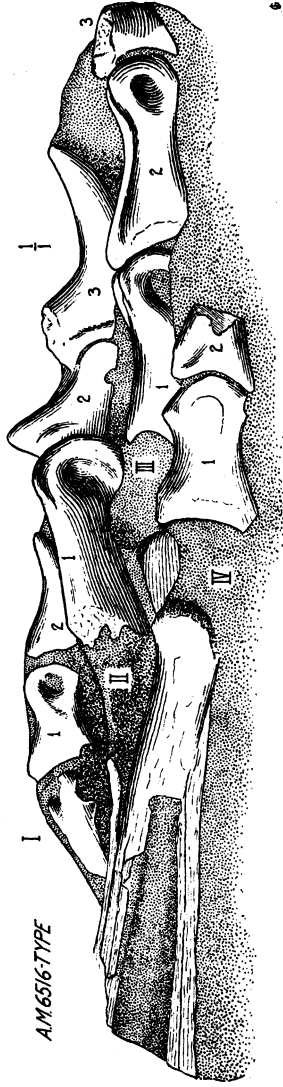


Fig. 5. Type of *Sauroornithoides mongoliensis* (Amer. Mus. 6516). Portion of left pes lying supine. Natural size.
 Foun. I with pelvis and hind limb in a concretion lying near the concretion containing the type skull of *S. mongoliensis* and probably belonging to the same individual.

terminal wanting; D.IV, 2+ ph., two terminals wanting; D.III apparently the largest. These appear to be of typical megalosaurian type. Weatherworn vertebræ in concretion are of cursorial not aquatic adaptation.

MEASUREMENTS

Length of skull, basioccipital to premaxillaries.....	192 mm.
Length of skull, occipital to anterior border of orbits.....	67
Length of face, anterior border of orbits to tip of premaxillaries.....	125
Faciocranial index.....	187%
Space occupied by dental series.....	73

From the above measurements it appears that the proportions of the face to cranium (187%) are approximately similar to those of *Velociraptor* (170%). The cranium as a whole is greatly elongated and the rostrum depressed toward the extremity. The apparent tapering and shallowness of the anterior part of the cranium are partly due to the fact that the lower jaws are thrust in between the upper, thus concealing the dental border and all the inferior teeth.

CONCLUSION.—Our conclusion, from the imperfectly preserved type skull and associated type hind limb, is that *Saurornithoides mongoliensis*, despite its elongate rostrum and flattened teeth, was a small cursorial theropod, more sluggish than *Velociraptor*, which was swift and raptorial in habit, but remotely related to it.

Oviraptor philoceratops, new genus and species

TYPE AND LOCALITY.—Djadochta beds at Shabarakh Usu, skull, jaws, cervical vertebræ and one fore limb, collected by George Olsen, July 13, 1923, Field No. 268 (Amer. Mus. 6517).

GENERIC CHARACTERS.—A diapsid reptile with eight craniofacial and mandibular fenestrations. Cranium exceeding facial region in length; entirely edentulous; probably related to the edentulous Ornithomimidæ. Skull extremely abbreviate; orbit and fenestrations exceptionally large. A large interclavicle. Manus tridactyl; metacarpals abbreviated; digits irregularly elongated as in the Ornithomimidæ; elements of digits not compressed laterally.

SPECIFIC CHARACTERS.—Faciocranial index 70%. Lower jaw with greatly elevated mandibular border and two mandibular fenestræ; prominent bony eminence above the rostrum. Scapula extremely elongate. Humerus, ulna and radius subequal. Digit II extremely elongate, D.I and III relatively abbreviate.

The unique toothless cranium, which forms the type of *Oviraptor philoceratops*, was found by Mr. George Olsen embedded in a nodule of reddish sand, which after careful preparation in the American Museum laboratory yielded the shattered appearance illustrated in figure 6. The upper figure shows the left side of the shattered type cranium of *Oviraptor*; the lower figure shows the right side of this shattered

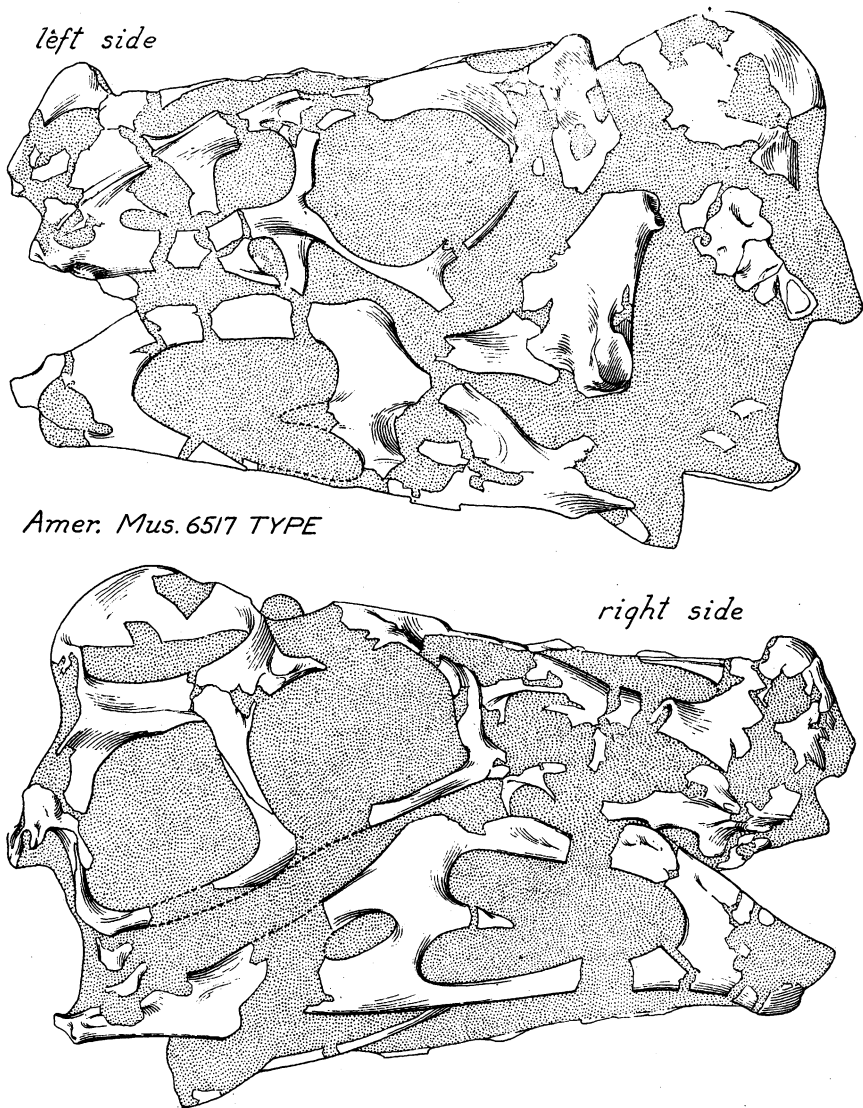


Fig. 6. Right and left aspects of type skull of *Oviraptor philoceratops* (Amer. Mus. 6517) exactly as it lay in the matrix, the shattered and widely separated condition of the bones as they appear embedded in the sandstone indicated by dots. One-half natural size.

cranium. Both figures correspond exactly with the type as it now appears in the matrix. Through very careful comparison of the bony elements represented on the right and left sides respectively, it proved possible to make the complete restoration of the right side of the cranium shown in figure 7. This cranium exhibits the following openings or fenestræ: (1) Supratemporal fenestra, exposing the parietal (pa.). (2) Laterotemporal fenestra, between the squamosal and jugal arches (l.t.f.). (3) Orbit, of large size, in mid-cranial region. (4) Antorbital fenestra (a.o.f.1); antorbital fenestra (a.o.f.2). (5) Anterior nares (nar.). (6) Mandibular fenestra (md.f.1); mandibular fenestra (md.f.2).

CHARACTERS.—This eight-fenestrated cranium is a marvel of lightly arched skull structure; the sutures are mostly closed; consequently the determination of the following cranial components by Professor Gregory is largely according to position and not according to sutures, namely: parietal, squamosal, opisthotic, quadratojugal, jugal, postorbital, frontal, maxillary, nasal. Sutural separation is indicated between the typical components of the lower jaw. The most remarkable feature, next to fenestration, lightness of the cranial arches and absence of cranial sutures, is the form of the skull and jaw. The cranium, vertically deep posteriorly, is shallow anteriorly to admit the elevated dentary portion of the jaw; the jaw, very shallow posteriorly, is vertically deep anteriorly, thus rising to oppose the shallow portion of the cranium.

HABITS.—The generic and specific names of this animal, *Oviraptor*, signifying the "egg seizer," *philoceratops*, signifying "fondness for ceratopsian eggs," may entirely mislead us as to its feeding habits and belie its character. The names are given because the type skull (Amer. Mus. 6517) was found lying directly over a nest of dinosaur eggs, the one photographed being actually separated from the eggs by only four inches of matrix. This immediately put the animal under suspicion of having been overtaken by a sandstorm in the very act of robbing the dinosaur egg nest.

This animal differs as widely as possible from *Velociraptor* and *Saurornithoides*, first, in the extreme abbreviation and depth of its skull, second, in its relatively long cranial and facial region, third, in the extraordinary fenestration of the side of the skull and jaws, there being eight fenestræ or openings in all, and, fourth and most important, the entire absence of teeth. The latter character removes it from the Megalosauridæ, to which we might refer the two skulls previously described, and relates it to the Ornithomimidæ, the toothless dinosaurs, although it differs generically from either *Ornithomimus* or *Struthiomimus*.

MEASUREMENTS

Length of skull, opisthotics to maxillaries.....	179 mm.
Length of cranial region, opisthotics to antorbital bar.....	111
Length of facial region, antorbital bar to premaxillaries.....	78
Faciocranial index.....	70%
Depth of skull, summit of parietals to angulars.....	112

These measurements and proportions present the widest possible contrast to those of the typical megalosaurian skull. The abbreviation of the facial region is especially distinctive. It is probable that the

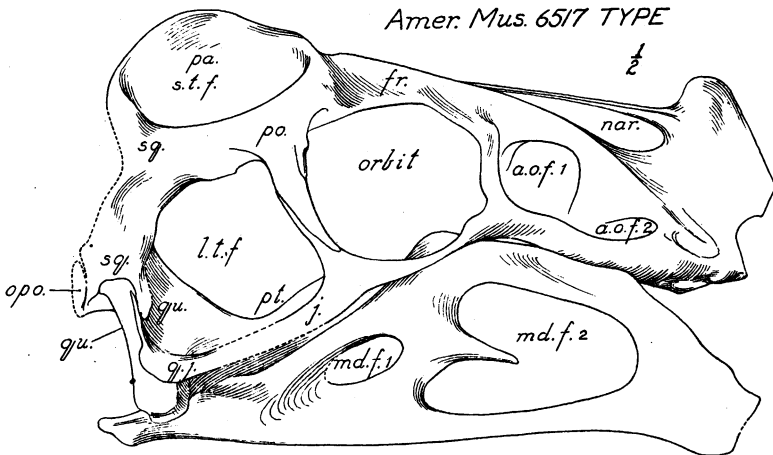


Fig. 7. *Oviraptor philoceratops* skull (Amer. Mus. 6517) reconstructed from right and left sides of original specimen as shown in Fig. 6. One-half natural size.

rostrum was sheathed in a horny beak, but there is no evidence of a predentary. Were it not for the evidence afforded by the fore limb and vertebræ, we should be completely at a loss to determine the relationships of this animal.

FORE LIMB.—Fortunately there was found associated with the skull the anterior portion of the skeleton (Fig. 8), including cervical vertebræ (C.V.), thoracic ribs (R), interclavicle (Ic.), the greater part of the left fore limb and supine right manus and portion of the prone left manus. So far as at present excavated from the rock, these are shown in figure 8. The interclavicle (Ic.) lies near its union with the extremely long and slender scapula (Sc.). The right manus lies supine, showing the palmar surface of Mtc. I (I) with the elongate first phalanx (1) and extremely long laterally compressed phalangeal claw (2); next lies Mtc. II (II) with three elongated phalanges (1, 2, 3), the terminal claw showing just

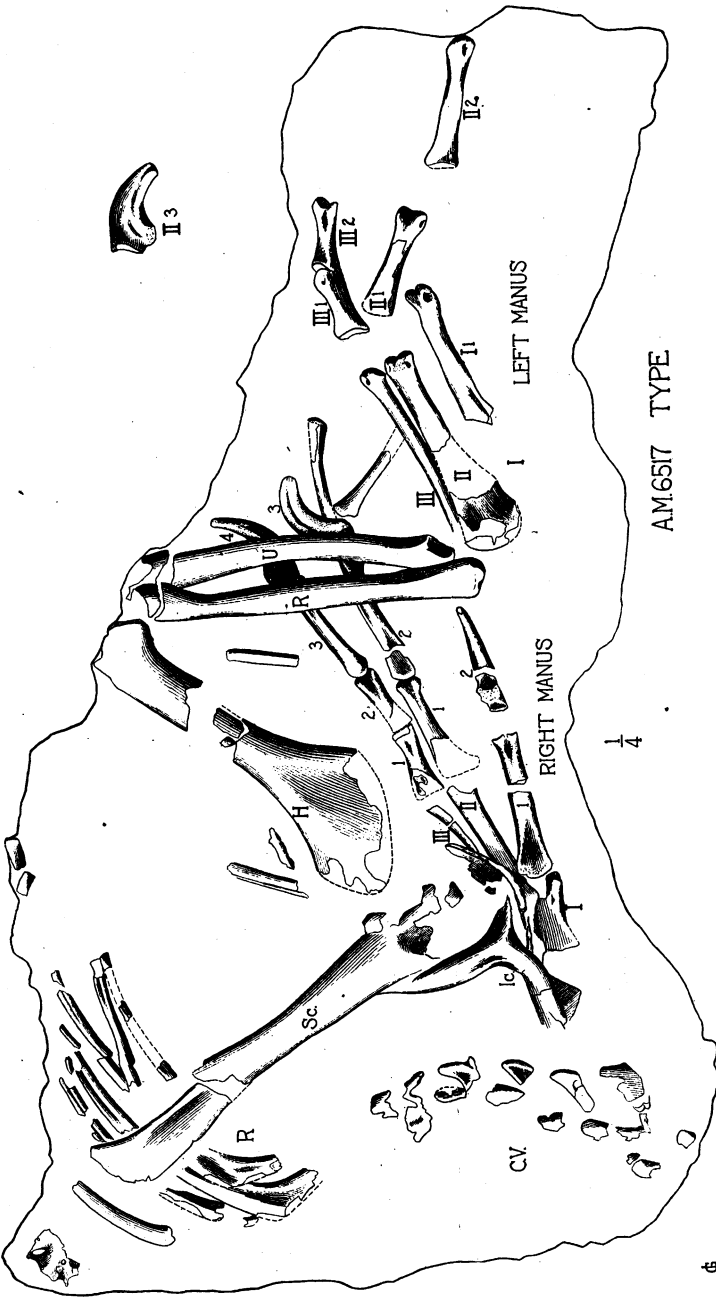


Fig. 8. Portions of left fore limb, also left and right manus of *Oviraptor philoceratops*. One-fourth natural size. Ic. = interclavicle. Sc. = scapula. H = humerus. I, II, III, = right manus with phalanges supine; left manus with phalanges prone.

beneath the ulna; next is the more slender Mtc. III (III) with four phalanges (1, 2, 3, 4). Fortunately in the more scattered left manus, which lies prone showing the dorsal surface, the second enlarged metacarpal (II) is preserved, also the reduced third metacarpal (III); what is presumed to be the third phalanx of the third digit (III, 3) was exposed at the edge of the block; the isolated claw (II, 3) was entirely weathered out and lying among the eggshell fragments on the surface.

Comparing this manus with that of *Ornitholestes* Osborn, of *Struthiomimus altus* Osborn, and of *Chirostenotes* Gilmore, as figured by Gilmore (1924, pp. 4 and 5), the extremely elongate second digit (II) of *Oviraptor* is analogous to that of *Ornitholestes* and of *Chirostenotes* rather than to that of the more symmetrical digits of *Struthiomimus*. On the contrary, the metacarpals and phalanges of *Oviraptor* are relatively broad, as in *Struthiomimus*, rather than extremely compressed laterally, as in *Ornitholestes* and *Chirostenotes*.

CONCLUSIONS

The discovery of these three new Theropoda in central Mongolia is extremely interesting and important. It tends to establish the theory that Mongolia was a highly fertile center of terrestrial dinosaur life in Lower Cretaceous times, as well as of mammalian life in Lower Tertiary times.

The three small carnivorous dinosaurs above described may be classified as follows:

Family Megalosauridæ:

Velociraptor mongoliensis, super-raptorial, certainly carnivorous; maxillo-dentary teeth $\frac{1}{4}$; teeth serrate on both borders.

Saurornithoides mongoliensis, raptorial, carnivorous or ovivorous; rostrum elongate; maxillo-dentary teeth $\frac{1}{8}$; teeth compressed, serrate on posterior borders only.

Family Ornithomimidæ:

Oviraptor philoceratops, herbivorous or ovivorous; cranium abbreviate; maxillo-dentary borders edentulous; manus tridactyl, attenuate.