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A MESOZOIC MAMMAL SKULL FROM MONGOLIA¹

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Among the many remarkable discoveries of the Third Asiatic Expedition of The American Museum of Natural History is a large part of the skull with associated lower jaws of a Mesozoic mammal. This unique specimen was found by A. F. Johnson in the Djadochta formation at ShabâraKh Usu in Mongolia. Mesozoic mammals are among the rarest of the fossils, and, while it might well have been inferred that there were multituberculates in Mongolia in Cretaceous times, this splendid confirmation is no less startling than it is welcome. Only one other partial Mesozoic mammal skull has been found, that of *Tritylodon* Owen (1884) from the Lower Jurassic of South Africa, and the lower jaw of the latter form is quite unknown. No Mesozoic mammal has hitherto been found in Asia, and, although mammals occur at earlier and later horizons, none has yet been found in a formation of age equivalent to the Djadochta. Consequently, this specimen is noteworthy, not only in being the second known skull, and the first with associated lower jaws, and as adding new morphological knowledge, but it also adds a new horizon to the stratigraphic range and a new continent to the geographic distribution. The writer is deeply indebted to Professor Osborn and Doctor Matthew for the great privilege of naming and describing this important form.

The preparation, a task calling for the greatest delicacy and address, owing to the softness of the bone and the nature of the sandstone matrix, has been undertaken with great skill by Mr. Albert Thomson. This preparation is not yet complete, but enough has been done to reveal all the essential features and to make possible this preliminary description.

Djadochtatherium matthewi, new genus and species

TYPE.—Amer. Mus. No. 20440. Anterior part of skull with associated lower jaw.

HORIZON.—Djadochta formation, early Upper Cretaceous, Mongolia.

GENERIC CHARACTERS.—A multituberculate of moderate size; the third upper incisors widely separated from the second ones and antero-internal to the first pre-

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molars; the lower premolars reduced to one; the lower molars with six cusps. (The specific characters are included in the following description.)

The anterior half of the skull is present and is well preserved save for the extreme tip and for a little distortion due to crushing. The palate anterior to P⁸ is present and exposed. The nasals and pre-

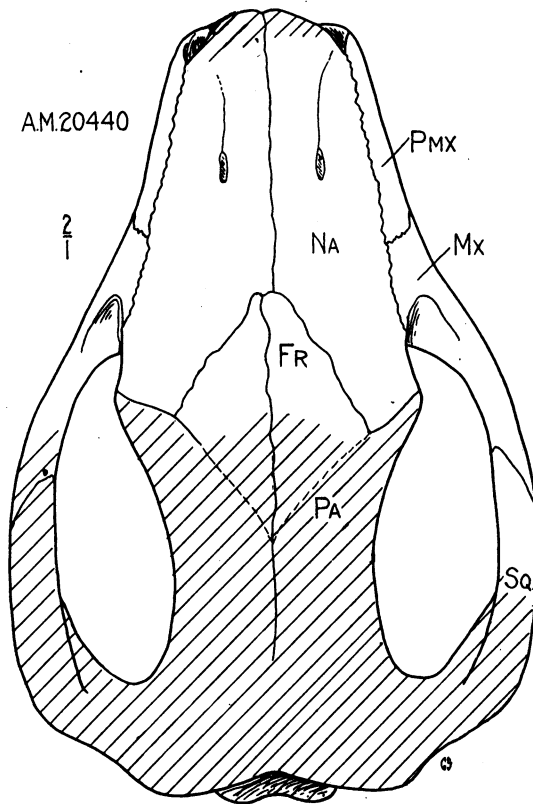


Fig. 1. *Djadochtatherium matthewi*, superior view of the type skull. $\times 2$.
The distortion has been corrected and the parts cross-lined restored.

maxillæ are present and complete, as are also the maxillæ save for the posterior parts of their alveolar and palatal portions. The sutures are well defined, and the only possibility of misinterpretation lies in the posterior upper part, where crushing has been most severe.

As seen from above, the facial region is triangular, resembling *Ptilodus* closely in this respect. Most of the upper surface is formed by the very large nasals, which are broad at all points but slightly more so

posteriorly. They reach back almost to the posterior border of the orbit and form a part of the superior border of the latter. The anterior parts of the frontals seem to be present; they come forward to a median point as in *Polymastodon* or *Ornithorhynchus*, and each was probably much reduced and triangular as in those genera. No part of the parietals is preserved, but from the shape of the nasals and frontals it seems fairly certain that they had a well-developed nasal contact at about the point where the nasals are broken off. The parietals did not reach the maxillæ.

The premaxilla is well developed with long maxillary and nasal sutural contacts, and is unusually elongated. It forms a larger part of the lateral aspect of the face than does the maxilla. The latter element

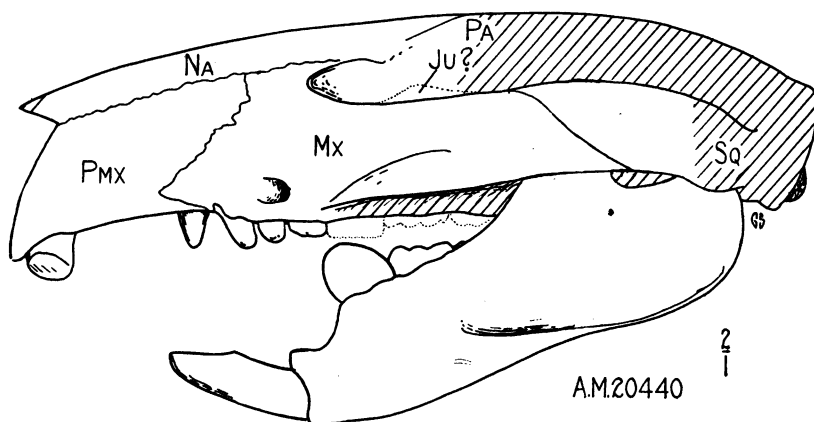


Fig. 2. *Djadochtherium matthewi*, side view of type skull and jaws. $\times 2$.
Only the parts not present on either side are cross-lined.

is also large, but with its strictly facial portion much reduced. It probably formed at least half of the zygomatic arch, which is uncommonly stout and arises opposite the third premolar. The infra-orbital canal is short, and the single foramen is situated not far from the alveolar border just anterior to the root of the zygoma.

There is no trace of a lacrymal bone, and this element is probably absent. Neither is there any trace of a jugal, and this bone, too, may have been totally absent. If present, it was very small and was confined to the upper part of the zygomatic arch.

A somewhat questionable but interesting feature is the apparent presence near the middle of each of the large nasals of a small elliptical foramen. These were present before burial, and their presence in both

nasals in symmetrical positions seems to indicate that they are original features of the animal. If so, the only condition which might be compared is that seen in *Ornithorhynchus*: the supra-orbital foramina of the latter are nearly but not quite inclosed within the nasals—if they became fully so they would agree in position with the present doubtful foramina. Anterior to these openings are two longitudinal cracks which are as well marked as sutures but which are probably due to pressure on the buried skull.

The palatal aspect, although incomplete posteriorly, is very instructive. The palatine processes of the premaxillæ are well developed and somewhat longer and broader than is usual. They meet in a slight

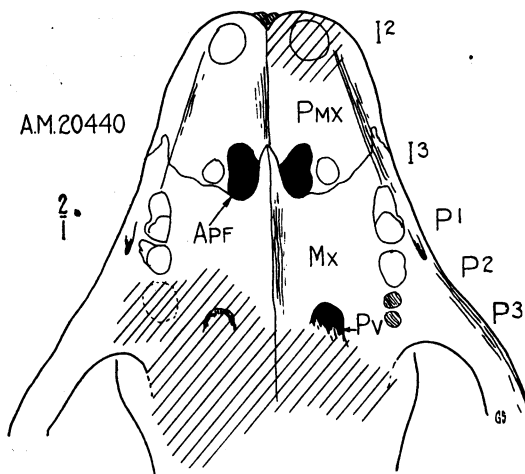


Fig. 3. *Djadochtatherium matthewi*, palatal view of type skull. $\times 2$.
Cross-lined parts restored.

groove along the midline. Consonant with the elongation of the premaxillæ, the anterior palatine foramina appear to have been shifted posteriorly, but they retain their relationships with the third incisors, being immediately internal to them as in other multituberculates.

The palatine portions of the maxillæ are also large, and meet in a low longitudinal ridge at the midline. Opposite the third premolar may be seen the anterior end of a small palatal vacuity.

The mandible is of the familiar multituberculate type, differing only in detail (and in some features of the dentition) from that, for instance, of *Ctenacodon*, and the resemblance to *Ptilodus* is even closer. Above the symphysis, where the two rami were loosely united by carti-

lage, is a small median bony protuberance such as is seen, for example, in the rat. The coronoid process arises with its anterior border outside the last molar. The process is small and is separated from the condyle by a large semicircular notch. The masseteric and pterygoid fossæ are not well defined anteriorly or superiorly, but the masseteric crest, although now broken off, was strong, while the pterygoid crest opposite it, on the inner side of the posterior portion of the mandible, was very promi-

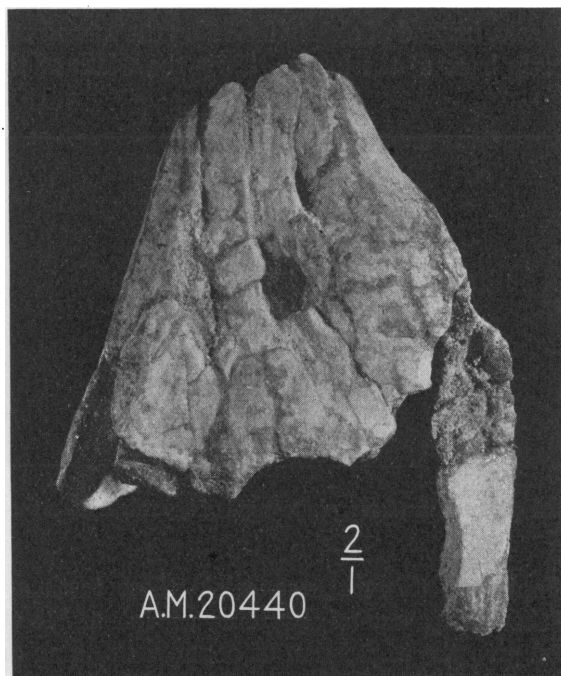


Fig. 4. *Djadochtatherium matthewi*, photograph of type skull from above. $\times 2$.

nent. As seen from above or below, its edge is a gentle, unbroken curve departing from near the condyle, and there is not the slightest reason to speak of an angle, inflected or otherwise.

The condyle is sessile, not marked off by a neck or constriction. The articular facet is roughly oval with its longest diameter in the same plane as the longitudinal axis of the jaw. It is convex in all directions, but more so along the longer diameter.

DENTITION.—The teeth, unfortunately, are on the whole very poorly preserved, and they leave a number of very important points to

be cleared up by hoped-for further finds. The dental formula, so far as indicated, is $\frac{2(3?) \cdot 0 \cdot 3 + 1}{1 \cdot 0 \cdot 1 \cdot 2}$ and it seems most probable that it was $\frac{2 \cdot 0 \cdot 4 \cdot 2}{1 \cdot 0 \cdot 1 \cdot 2}$. One cannot be sure that small first upper incisors did not occur as in *Tritylodon* and *Ctenacodon* (*Allodon*), but there is no indication of them. The second incisors are the largest and are implanted nearly vertically near the anterior end of the premaxillæ. Their tips did not meet in the midline. The apparent mode of wear is peculiar, for the worn facet, instead of facing backward, faces obliquely outward and forward. The third incisors, instead of closely following the second ones, are some distance directly back of the latter. Since the width of the palate ex-

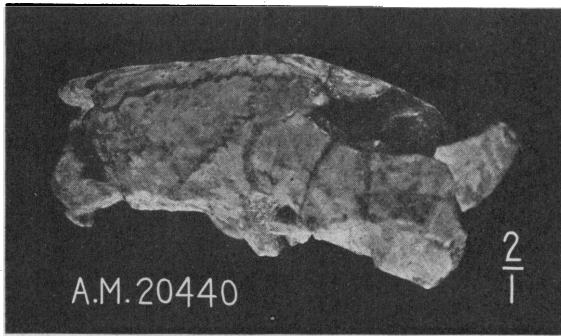


Fig. 5. *Djadochtatherium matthewi*, photograph of type skull from the side. $\times 2$.

pands considerably in this distance, while these teeth are but little farther apart than the preceding ones, they are internal to the border of the palate and give the impression of actually standing on the latter itself. This very unusual character, together with the reduction of the lower premolars and simplicity of the lower molars, may be considered diagnostic of the genus. These incisors were conical and pointed.

The upper premolars are so worn that their crowns are nearly shapeless. Two are preserved on the right side and two and the roots of a third on the left. On the left side, where they are a little less worn, it is seen that the crown of P^1 is nearly equilaterally triangular, with an angle external. On P^2 of this side two external cusps can be seen, one a little more external than the other, but the inner part of the crown seems to have been broken or worn off. The third premolar had two roots closely approximated, as had also the first and second, and was not larger than the second. There appears to be a diastema back of this

tooth, but in view of the condition of the specimen this remarkable impression may well be erroneous. Nothing remains of a possible fourth premolar or of the molars. Judging by analogy with other multituberculates, the large lower premolar would require a mate, the fourth premolar, in the upper series, and the two lower molars would each occlude with an upper molar, making the formula that indicated as probable at the beginning of this section. It is very improbable, in view of the small

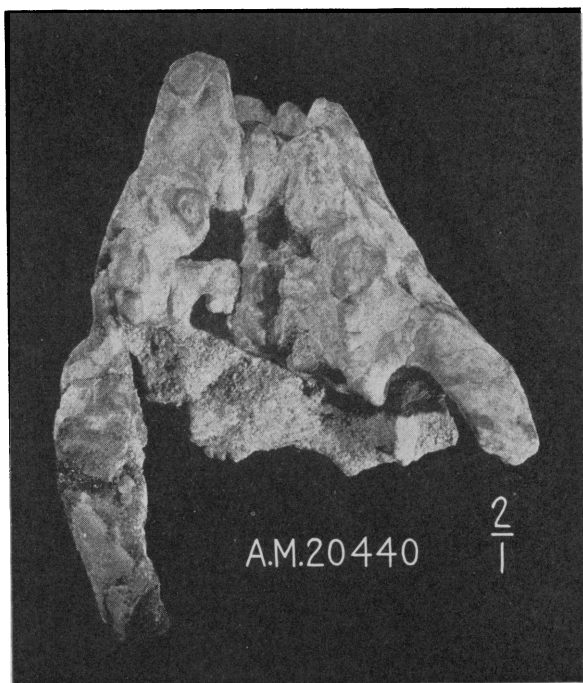


Fig. 6. *Djadochtatherium matthewi*, photograph of palate of type skull. $\times 2$.

amount of space between the lower molars and the incisors and in view of the reduction of the lower premolars, that there were five upper premolars as in *Ctenacodon* and *Plagiaulax*.

The lower dentition is much better known, although still hardly satisfactory. The incisors are remarkably stout, and their long curved fangs extended back at least to beneath P_4 or M_1 and undoubtedly were derived from a persistent pulp. The chief wear is on the superior (posterior) face, and here is developed a facet which faces backward and

inward. The premolar series has been reduced to a single tooth, P_4 . As preserved, this tooth is large, blunt, rather formless, and somewhat compressed laterally. It seems probable that it was a sharp-edged shearing tooth, but this is not absolutely demonstrated. The first

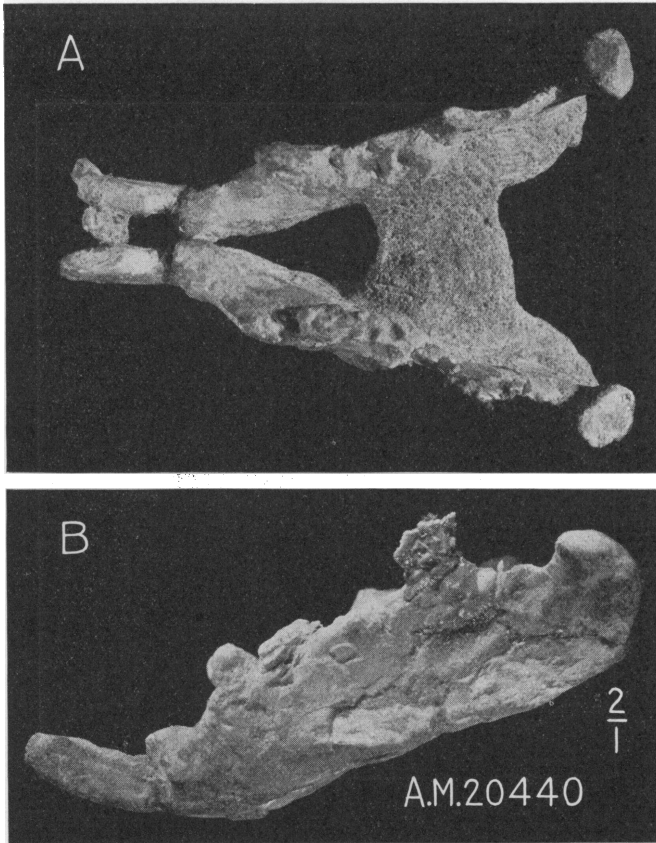


Fig. 7. *Djadochtatherium matthewi*, photographs of mandible of type. $\times 2$.

A, from above; B, from the side.

molar again is poorly preserved, not only badly worn but also broken. The crown had two longitudinal rows of cusps with a small number of cusps, quite surely three, in each. The posterior molar is unknown.

When the jaws were closed, the lower incisors had their tips inserted between the small posterior upper incisors. It seems certain,

however, that sufficient anteroposterior motion was possible for the lower incisors to work against the anterior upper ones—the facets on the two are complementary.

AFFINITIES

That *Djadochtatherium* is a multituberculate is, of course, obvious. That part of the dentition preserved is absolutely diagnostic, as are also the mandibular and cranial characters. The order Multituberculata may be divided into two great groups, one including *Tritylodon* and its allies and the other including all the upper Jurassic, Cretaceous, and Paleocene forms, with probably some earlier ones also. The *Tritylodon* group is characterized by almost undifferentiated upper cheek-teeth with three rows of two to four cusps each, and by the retention of a large lacrymal and jugal and of unreduced frontals. *Djadochtatherium* is plainly very distantly related to this group, if at all.

The other group, or suborder, which may be called the Plagiaulac-oidea in contrast to the Tritylodontoidea, is much in need of revision and of careful redefinition of the several families which compose it, but it is quite outside the scope and aim of *Novitates* to present this taxonomic revision here, and it will suffice to point out merely the course of evolution as it is now known. The uppermost Jurassic multituberculates have simple molars with six cusps each in two rows both above and below. There are four or three trenchant lower premolars, and five upper premolars, the last two of which are trenchant. In the Upper Cretaceous and Paleocene, the multituberculates have more complicated molars with two rows of cusps below and three above, and the first molar is larger and more complex than the second, instead of being nearly equal as in the Jurassic. In the more usual of these later types there is a trenchant lower premolar and sometimes another functionless one in front of this, and there are four upper premolars, only one of which, the last, is trenchant. In another type (*Polymastodon*), the premolars are reduced to a single conical one above and below. The cranial osteology is known only in two forms, *Ptilodus* and *Polymastodon*, but the Jurassic forms seem already to agree in the most striking specializations, i.e., the reduction or loss of the lacrymal and jugal.

On comparing the subject of this paper with these plagiaulacoids, the first impression is the remarkable agreement. If it were found in beds of age equivalent to the Djadochta formation, but in England or America, the Mongolian form would, indeed, be a new and marked type,

but not a surprising or anomalous one, and certainly a hypothesis of Asiatic or other exotic origin would be entirely unnecessary.

Djadochtatherium is in a very definitely Upper Cretaceous or, indeed, even Paleocene state of evolution. The reduction of the lower premolars is complete, for but one remains. The upper premolars, it must be inferred, were reduced to four, and of these only the last one can have been shearing. The size also is larger than that of any Jurassic forms but well within the range of the more common later genera. The simple character of the lower molars, if correctly interpreted, is a remarkably persistent feature in view of the specialization elsewhere. The equal size of the two lower molars, as also the small number of cusps, shows little or no advance beyond *Plagiaulax* or *Ctenacodon* of the Purbeck and Morrison. It is interesting that no known feature of *Djadochtatherium* precludes direct descent from these English and American Upper Jurassic forms.

The Mongolian mammal is, of course, very distinctive. The action of the lower incisors, the peculiar specialization of the upper ones, the early reduction of the lower premolar series, the prolongation of the premaxillæ, and the retention, in the face of these advances, of primitive molars, all place this form in a unique position. It could not possibly have been ancestral to any later known North American or European multituberculate, but is a member, perhaps the terminal member, of a hitherto unknown sideline of descent. Whether that line was close to that of the *Ptilodus*-like forms, the numerous Cretaceous and Paleocene ptilodontids, or whether its departure was in an entirely different direction, cannot be definitely asserted until the crucial upper molars are known. If these are simple, with only two rows of cusps and no indications of a third, *Djadochtatherium* would undoubtedly have to be placed in a different family, as will also be the case if, as is very possible, the unknown parts exhibit unpredictable peculiarities in keeping with those now known. If the upper molars are three-rowed, with twelve cusps or more, only a minor branch of the ptilodont stock would be indicated. The latter view may be adopted provisionally in view of the fact that the contour and size of the skull, shape of the lower jaw, premolar reduction and (so far as can be deduced) form, all agree remarkably with the later ptilodonts.

The cranial osteology is very similar to that of *Polymastodon*. The probable reduction of the frontals and the reduction or total loss of the lacrymal and jugal are significant, especially in view of the age of *Djadochtatherium*, which is much greater than that of *Polymastodon*, and

also in view of the great differences from the only other known Mesozoic mammal skull, *Tritylodon*.

So far as regards the bearing of this specimen on the affinities of the Multituberculata, a full discussion is not possible here. Many of the characters of *Polymastodon* and *Ptilodus* cited by Broom as indicating monotreme relationship are substantiated and carried back to a greater antiquity. In two features, the parietonasal contact without a parieto-maxillary one and the apparent presence of supraorbital foramina, *Djadochtatherium* resembles *Ornithorhynchus* even more than does *Polymastodon*, but these facts should not be overemphasized, not only because they are not very binding evidence of affinities but especially because their reality is not considered as established beyond all doubt.

CONCLUSIONS

The finding of a mammal in a later Mesozoic uplands formation of central Asia is an event which has been awaited by paleontologists with passionate interest, for it has long been felt by many that in such a formation the ancestors of the mammals which appear so suddenly in Europe and North America at the close of the Mesozoic might be found. *Djadochtatherium* goes far toward answering such anticipations with a firm negative. It is a Mesozoic mammal in every sense of the word, belonging to a previously known Mesozoic order, suborder, and probably family, and finding a possible structural ancestor in the Upper Jurassic either of England or of America. In conjunction with what we know of other faunas, it seems to indicate quite positively that the earlier Cretaceous mammals of Asia, Europe and North America were from a common source and not very different. Although the possibility is not to be flatly denied, it would be very surprising to find the ancestors of the Tertiary, or even of the Paleocene, placental mammals living with *Djadochtatherium*.

In any event, this fine specimen has permitted the description of a second Mesozoic mammal skull, the addition to the known multituberculates of a new and interesting adaptive type, the extension of the peculiar sort of cranial osteology seen in *Polymastodon* well down into the Cretaceous, and the addition of a new continent to the known range of the Mesozoic Mammalia.

