

AN ALBERTOSAUR FROM THE HELL CREEK FORMATION OF MONTANA

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ABSTRACT—An incomplete albertosaur skeleton from the Hell Creek Fm. of central Montana, differs from *Tyrannosaurus rex* in the proportions of the postcranial elements, and in the form of the articulations of some cranial elements. A slender form, slightly smaller than *T. rex*, is suggested by the remains. The specimen is tentatively referred to the genus *Albertosaurus*.

INTRODUCTION

DURING the summers of 1967-1969 a Los Angeles County Museum of Natural History field party, directed by Dr. R. MacDonald, collected a partial skeleton of a theropod on the L. D. Engdahl Ranch, Garfield County, Montana, from a quarry adjacent to that from which *Tyrannosaurus rex* (LACM 23844) was recovered. Initially the specimen was regarded as an immature *T. rex*: comparison of the cranial material with that of *T. rex* showed, however, that this was unlikely. Since the material represents a smaller, more gracile tyrannosaurid, it has tentatively been referred to *Albertosaurus* cf. *A. lancensis*. This reference is based on the parsimonious belief that it is more likely to pertain to a taxon known from the Maestrichtian (*A. lancensis*), than to a taxon known thus far from the Campanian (e.g. *Albertosaurus libratus*), although such is admittedly possible. Because *A. lancensis* is known only from a skull and jaws (CMNH 5741), the existence of postcranial material with this specimen is of particular interest, as it is the only such material known of a Maestrichtian tyrannosaurid in western North America other than *T. rex*. The problem of why postcranial remains of what was apparently a more abundant predator than *Tyrannosaurus* (Sloan, 1976) should be less frequently encountered than those of that genus, although interesting, will not be addressed here. It is also of interest in that the prefrontals are well-preserved and separated from the other cranial elements, thus enabling them to be separately described.

In this paper I use the term albertosaur in the sense of Welles and Long (1974), to refer to *Albertosaurus*, *Daspletosaurus*, *Dryptosaurus*, etc., and tyrannosaur to refer only to *Ty-*

rannosaurus. The term tyrannosaurid is used in the usual fashion, to refer to both albertosaurs and tyrannosaurs.

Russell (1970) revised the Canadian tyrannosaurids, and demonstrated the synonymy of *Gorgosaurus* and *Albertosaurus*. He specifically referred *Gorgosaurus lancensis* to the genus *Albertosaurus*, and comparison of his diagnosis of the genus *Albertosaurus* with the type material of *G. lancensis* leaves little doubt that this is correct. Although Russell regarded *Albertosaurus arctunguis* as a synonym of *Albertosaurus sarcophagus*, Welles and Long (1974) noted that the tarsus illustrated by Parks (1928) differed markedly from that of *A. sarcophagus*. Parks himself seemingly did not notice this difference (Parks, 1928, p. 30). Pending resolution of this situation, Russell's synonymy is here tentatively accepted.

ABBREVIATIONS

The following collection designations are used herein:

- AMNH—American Museum of Natural History, New York
- CM —Carnegie Museum, Pittsburgh
- CMNH—Cleveland Museum of Natural History, Cleveland
- LACM —Los Angeles County Museum of Natural History, Los Angeles
- MMS —Minnesota Museum of Science, St. Paul
- PIN —Palaeontological Institute, Academy of Sciences USSR, Moscow

DESCRIPTION

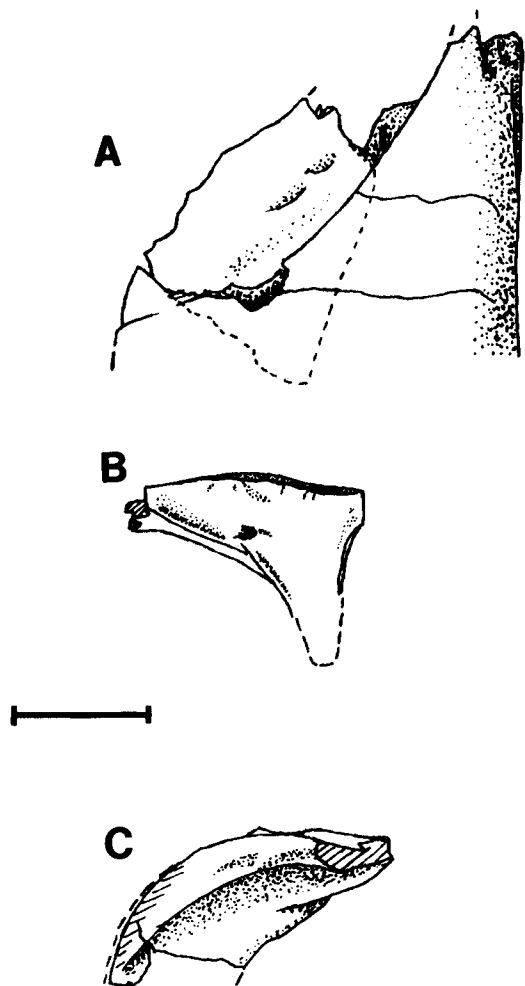
General.—This specimen attributed to *Albertosaurus* cf. *A. lancensis* (LACM 23845) is

represented only by limb material and fragments of the skull and jaws. This description will emphasize the postcranial elements, with sufficient attention to the cranial remains to demonstrate that the specimen is not referable to *Tyrannosaurus*. The prefrontal, not elsewhere described or well illustrated in the literature, will also be treated in detail. In view of the incompleteness of the material here described, and of the descriptions of albertosaur postcranial material by Lambe (1917) and Parks (1928) and of tyrannosaur postcranial material by Osborn (1906, 1916), this description will focus on differences of LACM 23845 from described forms. Detailed comparison, not possible with the other tyrannosaurids, was made with the disarticulated *Tyrannosaurus rex* skull (LACM 23844) collected from the adjacent quarry.

Nasal.—The nasals of LACM 23845 differ from those of *T. rex* (AMNH 5027, LACM 23844) in showing fewer and lower dorsal rugosities, and having an abrupt flexure in the sagittal plane. The nasals of *Albertosaurus libratus*, *Daspletosaurus torosus* and *T. rex* are straight or slightly convex: a similar flexure, however, is present in at least one specimen of *Tarbosaurus bataar* (PIN 551-3, Maleyev, 1974, Tab. II, fig. 1). The posteriormost portion of the nasals of LACM 23845 is lacking, but they appear to have narrowed posteriorly less markedly than those of *T. rex* (Osborn, 1912, Pl. 1), and more than in *A. libratus* (Russell, 1970, fig. 2). The nasal contact of the frontals was W-shaped and broader relative to the width of the frontals than in *T. rex*.

Maxilla.—The maxillae were minced prior to collection. The largest piece includes the anteroventral margin of the antorbital fossa and shows that it bounded the anteriormost antorbital fenestra as in both *Albertosaurus* and *Tyrannosaurus*.

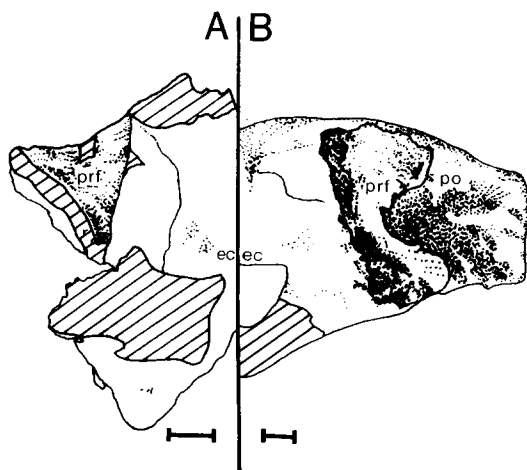
Lachrymal.—The horizontal ramus of the right lachrymal is preserved, showing the lachrymal 'horn' found in *A. libratus* was not present in this form. The lachrymals of the type specimen of *A. lancensis* are incomplete, the left poorly preserved, and the right apparently reconstructed in plaster, thus detailed comparison could not be made. In *T. rex* the horizontal ramus of the lachrymal is deeper dorsoventrally and the medial and lateral surfaces more nearly parallel than in this speci-



TEXT-FIG. 1.—Right prefrontal of *Albertosaurus* cf. *A. lancensis* (LACM 23845) in dorsal (A), anterior (B), and lateral (C) aspects. The dorsal view shows the prefrontal in articulation with the frontal, that portion of the prefrontal covered by the frontal indicated by the broken line. In B and C the broken region of this prefrontal is reconstructed with the dashed line. Bar represents 1 cm.

men (where they converge anteriorly). Additionally, the articular surface for the nasal is restricted to the lower half of the medial face of the lachrymal in LACM 23845, while in *T. rex* (LACM 23844) this surface occupies three-quarters of the height of that face.

Prefrontal (Text-fig. 1).—Both prefrontals are nearly complete. This specimen is the only one known to me in which the prefrontals have been freed from articulation with the oth-



TEXT-FIG. 2—The articular surface of the frontal for the prefrontal in anterior view. *A*, Right frontal of *Albertosaurus* cf. *A. lancensis*, LACM 23845. *B*, Left frontal of *Tyrannosaurus* sp., MMS 51-2004. The diagonal lines indicate broken surfaces. Abbreviations: ec, endocranial cavity; po, articular surface of frontal for postorbital; prf, articular surface of frontal for prefrontal. MMS 51-2004 includes portions of the laterosphenoid and prootic in addition to the frontal. Bars represent 1 cm.

er elements, and can thus be described in detail. The prefrontal is roughly tetrahedral in shape with the slightly convex base dorsally. The anterior face is smoothly concave on the left, and concave with a low ridge on the right prefrontal. The medial face smoothly curves into the posterior, and both are slightly convex: the anterior face only is clearly distinct from the others. The posterior and medial faces both articulate with the frontal, while the anterior contacts the lachrymal. The lack of published descriptions of theropod prefrontals prevents any comparisons with other taxa.

Frontal.—Both frontals are preserved: the right lacks only the postorbital articular surface, while of the left only the medial portion is present. The nasal contact is wider relative to the length of the frontals than in *T. rex*. In dorsal aspect the prefrontal contact is less angular than in *T. rex*, more like that of *A. libratus*. This contact is poorly preserved in the type specimen of *A. lancensis*.

A partial braincase of *Tyrannosaurus* sp. (MMS 51-2004) from South Dakota shows a prefrontal articular surface that is dorsoventrally elongate, concave and sutural (Text-fig.

2). That of LACM 23845 is triangular and smoothly concave. While some movement at this contact may have been allowed in the latter form, this was not the case in *T. rex*.

Parietal.—The anteromedial portions of the parietal are preserved, and are indistinguishable from those of *Albertosaurus* and *Tyrannosaurus*.

Supraoccipital.—The medial portion of the supraoccipital crest and adjoining portion of the sagittal crest are present. The dorsal margin of the sagittal crest reaches to the flattened dorsal margin of the supraoccipital crest posteriorly. In *T. rex* the dorsal margin of the sagittal crest does not extend so far dorsally, while both *A. lancensis* and *A. libratus* agree with LACM 23845. The right supraoccipital ala is thicker along its dorsal margin than the left. Interestingly, the supraoccipital crest of *A. libratus* (AMNH 5336), also shows such an asymmetry (not found in *T. rex*), but reversed, that is, with the thicker ala on the left. The supraoccipital alae of LACM 23845 are thicker than in the type specimen of *A. lancensis*.

Pterygoid.—Most of the quadrate processes of both pterygoids are present. They are thicker than usual for the quadrate of *T. rex* (although one specimen, CM 1400, matches them in thickness).

Quadratojugal.—Most of this element is preserved, represented by complementary pieces from right and left. In general form it agrees with those of other tyrannosaurids: those of the type specimen of *A. lancensis* are too incomplete for comparison. The upper quadrate articular surface of this element is polygonal in outline and sutural in *T. rex* (LACM 23845), and elliptical and smooth in *Albertosaurus* cf. *A. lancensis*. The anterior portion of that articular surface in *T. rex* (LACM 23844) is a marked concavity, while that of LACM 23845 lacks any concavity. The lower quadrate articular surfaces also differ, but both specimens are incomplete in this region and the extent of this difference is in doubt. No disarticulated quadratojugal of *Albertosaurus* could be located for comparison.

Dentary, angular and prearticular.—The central portions of the right dentary and of both angulars and both prearticulars are preserved. These are indistinguishable from those of *Albertosaurus* and *Tyrannosaurus* except that the ventral margin of the posteroventral

process of the dentary bears posteriorly a small, distinct medial shelf in *T. rex* (LACM 23844) absent in LACM 23845.

Surangular.—Most of the right, but only fragments of the left surangular are preserved. The anterior dentary process lacks the internal, longitudinal bar found in *T. rex* (LACM 23844).

Ulna (Text-fig. 3).—The left ulna lacks only the radial and olecranal edges of the proximal articular surface. Expanded at both ends, it has a slight taper distally in lateral view. The proximal articular surface is inclined at about 45° to the long axis of the ulna, and both it and the distal articular surface are subtriangular in shape. There is no sign of a pronounced olecranal process as in *Albertosaurus* and *Daspletosaurus*, the ulna most resembling that of juvenile *Albertosaurus libratus* (AMNH 5664). The shaft tapers less than in any other tyrannosaurid. As in *Deinonychus antirrhopus* (Ostrom, 1969) the margins of the joint capsule at the distal extremity are traceable as a distinct angulation of the surface: the radial surface has a slight rugose ridge distally, similar to that of *D. antirrhopus* suggested by Ostrom (1969) as the attachment of the distal radioulnar ligament. The ulna is 131 mm long, and 26 mm in distal diameter.

Metacarpal (Text-fig. 3).—The metacarpal II is broader than deep. It is 70 mm long, 29 mm in maximal proximal diameter and 21 mm in maximal distal diameter.

Manual ungual phalanx (Text-fig. 3).—The ungual lacks the tip and a portion of the basal proximal angle. It differs from those of *A. libratus* (and *Tarbosaurus bataar*) in that, although incomplete, it shows no sign of a proximal tendon tubercle, which thus must have been poorly developed at best. In lateral aspect the proximal articular surface of the manual claw of tyrannosaurids (and most theropods) is arcuate in the sagittal plane: in this specimen it is not arcuate, but consists of two nearly plane surfaces meeting at an oblique angle. Such an angled surface would have reduced the mobility of this claw on the adjacent phalanx.

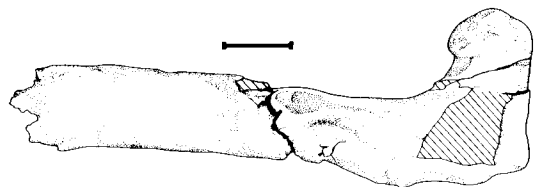
Femur (Text-fig. 4).—The proximal two-thirds of the left femur is present. The lesser trochanter is broken away, and the shaft crushed so that reliable measurements of the diameter cannot be made. The femur, with



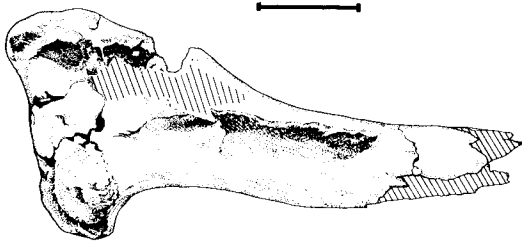
TEXT-FIG. 3—Ungual phalanx (A), metacarpal (B) and left ulna (C) of *Albertosaurus* cf. *A. lancensis* (LACM 23845) in lateral aspect. Bar represents 5 cm.

long, straight shaft and marked, offset head, resembles those of other tyrannosaurids, but appears more slender than most. The proximal proportions match those of the femur of *Dryptosaurus aquilunguis* (Cope, 1871), but the shaft is less curved in the sagittal plane. The fourth trochanter is less prominent than in adult tyrannosaurids, but resembles that of juvenile *A. libratus* (AMNH 5664). It appears more proximally placed than in *D. aquilunguis*, but the incompleteness of the femora of both forms makes it difficult to be sure. Comparing the ratio of the width of the proximal end to the distance from that end to the distal termination of the fourth trochanter suggests that the trochanter in LACM 23845 is more proximally placed than in *A. libratus* or *T. rex*.

Tibia (Text-fig. 5).—The proximal half of the left tibia is preserved. In proximal view it is roughly triangular in form and narrower than those of other albertosaurs, which are roughly quadrangular, except '*Gorgosaurus*' *novojilovi* (Maleyev, 1974). The cnemial and fibular crests are well-developed. The cnemial crest extends further laterally than in other albertosaurs, except '*G.*' *novojilovi*, projecting to a position anterior to the head of the fibula. This tibia, as preserved, most closely resembles those of *Coelosaurus antiquus* (Leidy, 1865, Pl. III, fig. 3) and '*G.*' *novojilovi*. The



TEXT-FIG. 4—Femur of *Albertosaurus* cf. *A. lancensis* (LACM 23845) in anterior aspect. Diagonal lines indicate broken surfaces. Bar represents 10 cm.



TEXT-FIG. 5.—Left tibia of *Albertosaurus* cf. *A. lancensis* (LACM 23845) in medial aspect. Diagonal lines indicate broken surfaces. Bar represents 5 cm.

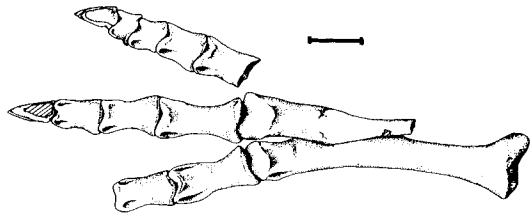
tibial condyles are prominent, the lateral condyle showing an anterior projection also seen in *A. sarcophagus* (Parks, 1928, fig. 13), but not in *A. libratus* (Lambe, 1917, fig. 43).

Fibula (Text-fig. 6).—The right fibula is complete. In lateral view the proximal expansion is roughly symmetric about the midline, a condition found in *D. aquilunguis* but not in other tyrannosaurids. The fibula is more slender than those of *T. rex* (LACM 23844) and *D. aquilunguis*. The anterior margin is less convex in lateral view, and the dorsal margin more nearly flat than in *T. rex*, both character states being shared with *A. sarcophagus* and *A. libratus*.

Astragalus.—The right astragalus has been described and figured by Welles and Long (1974). They have concluded that it resembles those of the albertosaurs and is quite distinct from that of *T. rex* (AMNH 5027). It should be noted however, that an incomplete astragalus collected with the remains of *T. rex*, LACM 23844, and attributed to that specimen (being of the appropriate size) does not resemble the astragalus attributed to AMNH 5027, but rather the albertosaur astragali. Welles and Long (1974) felt that the astragalus of *Dryptosaurus aquilunguis*, interpreted as



TEXT-FIG. 6.—Right fibula of *Albertosaurus* cf. *A. lancensis* (LACM 23845), in lateral aspect. Diagonal lines indicate broken surfaces. Bar represents 10 cm.



TEXT-FIG. 7.—Metatarsus and pes of *Albertosaurus* cf. *A. lancensis* (LACM 23845). Diagonal lines indicate broken surfaces. Bar represents 10 cm.

worn, was the closest in form to that of LACM 23845.

Metatarsus (Text-fig. 7).—The right metatarsal II and distal half of metatarsal III are present. They resemble those of *A. libratus*, with indication of the characteristic proximal narrowing of metatarsal III. The proximal face of metatarsal II bears a prominent expansion laterally, like those of *T. rex* and adult *A. libratus*, but absent in *A. sarcophagus* (Parks, 1928) and juvenile *A. libratus* (AMNH 5664). These metatarsals are less stout than those of *T. rex*, but stouter than those of '*G. novojoilovi*'.

Pedal phalanges (Text-fig. 7).—Eleven phalanges of the right pes are present, more or less complete. They are indistinguishable from those of albertosaurs, and only slightly more slender than those of *T. rex* (LACM 23844).

COMPARISONS

The form of the quadratojugal and of the metatarsus of LACM 23845 indicate that this specimen represents a tyrannosaurid. Comparison with *Tyrannosaurus* (AMNH 5027, LACM 23844 and MMS 51-2004) shows several cranial differences that appear significant: width of the posterior portion of the nasals; lachrymal-nasal articulation; frontal-prefrontal articulation; quadratojugal-quadrato articular crest; relation of sagittal and supraoccipital crests. Other differences (e.g. in nasal form) may well be individual anomalies or age dependent features. These differences are reinforced by differences of proportion of the limb elements and of the form of the fibula. The limb element proportions match those of *Albertosaurus*, as do some of the cranial features (e.g. form of the horizontal ramus of the lachrymal) in which LACM 23845 differs from *T. rex*.

Rozhdestvenskii (1965) found that in *Tarbosaurus bataar* postcranial material of immature specimens was more slender than that representing adult specimens, while Russell (1970) found a very similar situation for *Albertosaurus libratus*. Rozhdestvenskii had also suggested that *Albertosaurus lancensis* might be an immature *Tyrannosaurus rex*, a suggestion with which Russell disagreed, pointing out that the type specimen of *A. lancensis* showed tightly interlocking cranial sutures and well developed supraoccipital alae, both of which indicated adulthood. Because LACM 23845 does not show tightly interlocking cranial sutures and does show more slender proportions than *Tyrannosaurus* the reasons for not regarding it as an immature *Tyrannosaurus* must be clearly stated. These are three: first, the supraoccipital alae are well-developed; second, the marked difference in the form of the prefrontal-frontal and the quadratojugal-quadrato articulations from those of *Tyrannosaurus*; and third, the difference in form of the proximal fibula from that of *Tyrannosaurus*. Because the length of the fibula of LACM 23845 is about 80% that of *T. rex* (LACM 23844) I regard it as unlikely that the form of the articulations or the proximal part of the fibula could change in the required amount during the remaining growth, were LACM 23845 an immature *T. rex*.

Two Maestrichtian North American theropod taxa might accommodate this material, neither of them well known. These are *Albertosaurus lancensis* (Gilmore, 1946), represented by the type skull and jaws, and *Dryptosaurus aquilunguis* (Cope, 1866, 1871) represented largely by incomplete postcranial elements. The recent assertion that many of the Maestrichtian dinosaurs of New Jersey in fact pertain to genera known from the Rocky Mountains (Baird and Horner, 1977), emphasizes the possibility that LACM 23845 might belong to *Dryptosaurus*. There are some specific points of resemblance in the form of the astragalus and the manual claws, that of *D. aquilunguis* having a poorly developed basal tubercle as well as the closest approach to LACM 23845 in form of the proximal articular surface. *Dryptosaurus* is the only other form to have a 'symmetrical' proximal fibula, however the form and proportions of the rest of the fibula differ, and the ventral end is much

more acute in *Dryptosaurus* than in LACM 23845.

Although recognizing that incomplete material of several of the forms here considered makes comparison difficult, there seem to be more resemblances to *Albertosaurus* than to *Dryptosaurus*. Specifically LACM 23845 resembles *Albertosaurus* in: form and proportions of metatarsus; proportions of fibula; relation of sagittal to supraoccipital crest; form of horizontal ramus of lachrymal; form of distal fibula. LACM 23845 seems unique among tyrannosaurids in the subdued olecranal process of the ulna, the angulate proximal articulation of the manual claw, and the absence of a lachrymal 'horn.' Reference to *A. lancensis* is largely on stratigraphic grounds: the material is too incomplete to support reference to taxa not otherwise known from the Maestrichtian, such as *A. libratus*, *A. sarcophagus* or *Daspletosaurus torosus*.

DISCUSSION

The total length of the skull of LACM 23845 can be estimated as the nasals, frontals and most of the parietals are present. The skull was approximately equal in length to the fibula. This was not the case for *T. rex* nor *D. torosus* (Russell, 1970, fig. 8 and Table of Measurements which gives tibial length, noting that this exceeds fibular length, but is shorter than the skull), and I have been unable to find in the literature measurements for the fibula and skull of any single specimen of *Albertosaurus*. The skull of *Albertosaurus* cf. *A. lancensis* was relatively smaller than that of *T. rex*.

The frontals and parietals of LACM 23845 are at most 10% longer than those of the type skull of *A. lancensis*, while the nasals are about 25% longer. This suggests a relatively longer snout than in the type skull.

The open cranial sutures and poor development of the olecranal process suggest that this specimen may not have been adult. This is contraindicated by the development of the supraoccipital alae, and the projection of the proximal face of metatarsal III, as well as the large size of the individual (skull elements and fibula about 80% as long as those of adult *T. rex*).

The slenderness of the hind limb elements, the development of the cnemial crest, and the

probably proximal position of the fourth trochanter suggest a swift-footed form, not as fast as the ornithomimids (Russell, 1972), but faster than most other tyrannosaurids. The form of the ungual phalanx suggests that the forelimbs were less efficient for the catching and subduing of prey than in other albertosaurs. The specimen provides information about a second large predator that coexisted with *Tyrannosaurus rex*: the manual claw and relatively small skull suggest that this form fed upon smaller prey, or in some other fashion different, than *T. rex*.

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