

## B R E V I O R A

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LOWER VERTEBRATES FROM THE LATE CRETACEOUS  
HELL CREEK FORMATION, McCONE COUNTY,  
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**ABSTRACT.** Fifty-five lower vertebrate species are recorded from the Upper Cretaceous Bug Creek Anthills locality, Hell Creek Formation, McCone County, Montana. This faunal list closely resembles that from the Lance Formation of Wyoming, also of late Cretaceous age (Estes, 1964). In spite of this general similarity, a number of species are present at Bug Creek Anthills that are absent from the Lance Formation sample: Cf. *Paralbula casei* (Albulidae; Phyllodontidae), *Palaeolabrus montanensis* (Amiiformes?; Palaeolabridae), *Proamphiuma cretacea* (Caudata; Amphiumidae), an unidentified discoglossid frog, an undescribed baenid turtle, *Adocus* sp. (Testudinata; Dermatemydidae), *Peneteius aquilonius* (Sauria; Teiidae), and an unidentified boid snake.

Both Bug Creek Anthills and the Lance localities are in the upper third of Hell Creek and Lance Formation sections, respectively. A similar floodplain-riparian association of freshwater and terrestrial forms occurs in both areas, including hybodontid, pristid, and dasyatid sharks; sturgeons and paddlefish; amiid, albulid, and sciaenid fishes; six genera of salamanders; four genera of frogs; seven genera of turtles; eleven genera of lizards; two genera of snakes; two genera of crocodilians; and eight genera of dinosaurs. Slight climatic, ecological, and geographical differences are probably responsible for the minor differences between Lance and Hell Creek faunas: that from the Bug Creek Anthills locality is not notably more advanced in character than that from the Lance.

## INTRODUCTION

In the summers of 1962, 1963, and 1964, Robert E. Sloan and his associates at the University of Minnesota collected a series of samples of vertebrate fossils at and near Bug Creek. McCone County, Montana, in the late Cretaceous Hell Creek Formation. The richest of these localities, Bug Creek Anthills, has yielded an extraordinary sample of disarticulated fossil vertebrate material

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(Sloan and Van Valen, 1965; Estes, 1965, 1969d-h; Estes and Berberian, 1969). In the next paper in this series (Estes and Berberian, in press), paleoecological techniques developed by Shotwell (1955, 1958) will be applied to the MCZ sample from Bug Creek Anthills; we here provide only an annotated faunal list of the lower vertebrates at this locality (for collections used, see Acknowledgments). A few taxa present locally in localities at or above the Bug Creek Anthills level (noted in the text) are also included, and a complete list of known Hell Creek Formation vertebrates will be included in Estes and Berberian (in press).

Since many thousands of specimens have been recovered, the individual bones and their frequency of occurrence are not listed in the systematic section. Minimum numbers of individuals and relative abundance of species are given in Table 1; similar data are also given for the Lance Formation, for comparison.

#### ANNOTATED LIST OF LOWER VERTEBRATES

The faunal list from Bug Creek Anthills is very similar to that described from the Lance Formation of Wyoming (Estes, 1964), as shown in Table 1, and a similar floodplain-riparian environment of deposition and rather similar climatic conditions are indicated. The two local faunas show the same relative abundance of most forms, thus indicating, to a certain degree, that the samples probably reflect actual abundance. Therefore, only those comments supplementing or modifying conclusions reached by Estes (1964) appear here. A detailed paleoecological analysis and comparison of the Bug Creek Anthills and Lance local faunas will appear in Estes and Berberian (in press).

TABLE 1

Minimum number of individuals and relative abundance of lower vertebrates in two localities.

Lower vertebrates	Lance Formation (V5620)		Hell Creek Formation (Bug Creek Anthills)	
	MNI	RA	MNI**	RA
<i>Lonchidion</i>	4	1.0	1	.3
<i>Myledaphus</i>	1	.2	1	.3
<i>Squatirhina</i>	1	.2	X	X
<i>Ischyrhiza</i>	1	.2	X	X
<i>Acipenser</i>	1	.2	7	1.8
<i>Paleopsephurus</i>	1*	.2	3	.5
" <i>Protamia</i> "	1	.2	1	.3
<i>Amia</i>	103	21.0	94	19.4
<i>Belonostomus</i>	5	1.0	1	.3



<i>Lepisosteus</i>	7	1.4	25	5.5
<i>Coriops</i>	26	4.5	3	.5
<i>cf. Paralbula</i>	X	X	1	.3
<i>Palaeolabrus</i>	X	X	7	1.6
Elopidae	1	.2	1	.3
<i>Platacodon</i>	42	8.2	2	.4
<i>Habrosaurus</i>	73	14.1	9	1.8
<i>Opisthotriton</i>	41	8.0	107	22.9
<i>Scapherpeton</i>	22	4.2	61	14.4
<i>Lisserpeton</i>	1*	.2	72	12.8
<i>Prodesmodon</i>	11	2.2	2	.4
<i>Proamphiuma</i>	X	X	2	.4
<i>Scotiophryne</i>	1*	.2	6	1.2
<i>cf. Barbourula</i>	1	.2	1	.3
other frogs	12	2.4	3	.5
<i>Adocus</i>	X	X	1	.3
<i>Basilemys</i>	1	.2	X	X
<i>Compsemys</i>	1	.2	1	.3
<i>Trionyx</i>	1	.2	1	.3
<i>Eubaena</i>	1	.2	3	.5
other baenids	1	.2	4	.8
Emydinae	1	.2	3	.5
<i>Brachychampsia</i>	1	.2	1	.3
<i>Leidyosuchus</i>	1	.2	1	.3
<i>Champsosaurus</i>	1	.2	2	.4
dinosaurs	8	1.6	7	1.8
<i>Peneteius</i>	X	X	1	.3
<i>Chamops</i>	15	3.0	3	.5
<i>Meniscognathus</i>	15	3.0	X	X
<i>Leptochamops</i>	15	3.0	1	.3
<i>Haptosphenus</i>	3	.5	1	.3
<i>Contogenys</i>	X	X	4	.8
<i>Sauriscus</i>	4	.8	X	X
<i>Exostinus</i>	4	.7	3	.5
<i>cf. Gerrhonotus</i>	3	.6	X	X
<i>Pancelosaurus</i>	20	4.0	15	3.2
<i>Parasaniwa</i>	36	7.0	1	.3
<i>Paraderma</i>	2	.4	1	.3
<i>Palaeosaniwa</i>	1	.2	1	.3
<i>Colpodontosaurus</i>	2	.4	3	.5
<i>Litakis</i>	1	.2	X	X
<i>Cuttysarkus</i>	13	2.5	2	.4
<i>Coniophis</i>	1	.2	1	.3
boid snake	X	X	1	.3
?Pterosauria	1	.2	X	X
Total	509	100.0	472	100.0

\*Additions since Estes, 1964, Table 5.

\*\*Only MCZ sample used in this calculation.



## CLASS CHONDRICHTHYES

## ORDER SELACHII

## Family Hybodontidae

*Lonchidion selachos* Estes, 1964

MCZ 9330, teeth and cephalic spines, resemble those figured by Estes (1964, figs. 1, 2d, 3a-b, d) from the Lance Formation of Wyoming. None of the tricuspid teeth with squatinoid roots interpreted by Estes (1964, figs. 2a-c, 3c) as anterior or symphyseal teeth occur in the Bug Creek sample. Patterson (1966, p. 331), in describing Jurassic and Cretaceous English species of this genus, suggested that these tricuspid teeth belonged either to *Squatirhina americana* or to an undescribed taxon. The preservation and appearance of the tricuspid Lance teeth indicate that they belong to a squatinoid other than *Squatirhina*. Patterson (1966, p. 326) has referred tricuspid teeth (presumed symphyseal teeth) to his Jurassic species *L. heterodon*, but no root structure is known. As he says (1966, p. 331), it is possible that *Lonchidion*, like *Heterodontus*, developed anterior tricuspid teeth with squatinoid roots, but we agree with him that the Lance tricuspid teeth do not belong to *Lonchidion*.

## ORDER BATOIDEA

## Family Pristidae

*Ischyrhiza avoncola* Estes, 1964

Only one specimen of this species is represented; it is American Museum of Natural History 9330, from the Harbicht Hill locality, which is about the same stratigraphic level as Bug Creek Ant-hills and about twenty miles away. Both Bug Creek Anthills and Harbicht Hill are termed transitional or ". . . of Paleocene aspect . . ." by Sloan and Van Valen (1965).

The specimen is 5.0 mm long, its crown flattened and keeled anteroposteriorly. The base is extensively and evenly eroded; the etched appearance suggests that it may have been of coprolitic origin (Fig. 1a-b).

*Ischyrhiza avoncola* is recorded from the Cretaceous and Paleocene of Texas by Slaughter and Steiner (1968), who note that it seems distinct from larger species of *Ischyrhiza* and *Onchosaurus* and is therefore unlikely to represent young of such larger forms. They have also noted a possible Turonian-Paleocene size increase in *I. avoncola*. The Paleocene Kinkaid Formation specimen figured by Slaughter and Steiner (1968, fig. 3m) is about 3.5 mm



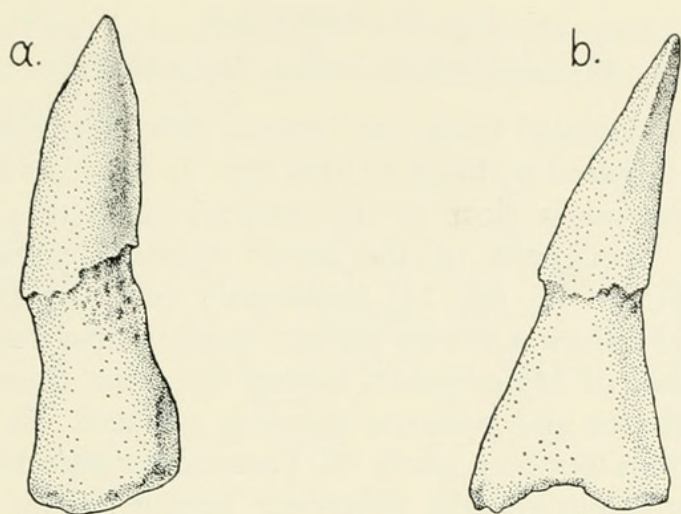


FIG. 1. *Ischyrrhiza avoncola*, AMNH 9330, rostral tooth; *a*, dorsal, and *b*, anterior views; Harbicht Hill, Hell Creek Formation, McCone County, Montana;  $\times 8$ .

long, which is about maximum size of Lance Formation specimens (Estes, 1964, p. 14). They state (1968, p. 237) that their Turonian Eagle Ford Formation specimens are smaller than those from the Lance Formation and the one they figure (1968, fig. 3k) is about 1.8 mm long, not significantly smaller than the minimum 2.0 mm of Lance specimens. Their figure 3k-m, offered as a temporal sequence of size change, thus represents approximately the size variation occurring within Lance Formation specimens, although they state (1968, p. 236) that the "... size of the teeth in the Lance collections is very constant ...". Since they do not give size range for any of their samples, it is difficult to know in what part of the observed range their figured specimens fall. However, the Harbicht Hill specimen is 5.0 mm in total length, significantly exceeding the known range of Lance specimens. The crown of the Harbicht Hill specimen is longer relative to the base than in other specimens of this species, but this condition is partly the result of erosion. In other features it does not differ from *I. avoncola* and can be referred to it without much doubt. A late Paleocene specimen from Wyoming (Shotgun member, Fort Union Formation, specimens collected by Craig Wood) is 3.9 mm long. This specimen and that from Harbicht Hill may provide substantiation for Slaughter and Steiner's suggestion of temporal size increase in *I. avoncola*, and may also strengthen the "Paleocene aspect" of the Harbicht Hill locality suggested by Sloan and Van Valen (1965).



## Family Dasyatidae

*Myledaphus bipartitus* Cope, 1876

MCZ 9331, isolated teeth and dermal denticles, closely resemble specimens figured by Estes (1964, figs. 7, 8d). As indicated by Estes, *Myledaphus* is close to the African late Cretaceous *Parapalaeobates*. Specimens of the latter figured by Stromer and Weiler (1930, pl. II, fig. 15; incorrectly cited by Estes, 1964, p. 18, as 1913) show a crown pattern coarser than but essentially identical to that of *Myledaphus*, having the same transverse ridge separating anterior and posterior grinding surfaces. In view of the great similarities between teeth of *Parapalaeobates* and *Myledaphus*, no more than specific difference between them is justified. Although histological comparison has not yet been made, we doubt that differences supporting generic separation could be found; we therefore suggest (1) that *Parapalaeobates* be considered a junior synonym of *Myledaphus*, thus extending the range of the latter genus to the Upper Cretaceous of North Africa, and (2) that *M. pygmaeus* be separated from *M. bipartitus* by its relatively coarser sculpture and more flattened, rounded crown. In spite of the name, the teeth of *M. pygmaeus* are as large as the largest specimens of *M. bipartitus*.

## CLASS OSTEICHTHYES

## ORDER ACIPENSERIFORMES

## Family Acipenseridae

*Acipenser eruciferus* Cope, 1876

MCZ 9433-9442, 9448-9450. Fragmentary pectoral spines, cleithra, clavicles, supracleithra, pterotics, dermosphenotics, supraorbitals, (?) dermosupraoccipitals, (?) parietals, hyoid elements, ventral precaudal scute, and dermal scutes have been recovered; terminology of Gregory (1933) for the dermal bones is followed. The dermal sculpture of specimens that possess it is varied; pustular, ridge-and-valley, and pitted types occur, depending on element and size, but a latticelike pattern occurs on most specimens. The sculpture is fine in small specimens, much coarser in larger ones. Many *Acipenser*-like lateral scutes occur (Estes, 1964, fig. 11a; Lambe, 1902, pl. 21). Such scutes also appear in living *Scaphirhynchus*, although scute sculpture is less coarse than in *Acipenser*, at least in our comparative material. Many tiny, comb like scutes like those covering the body of Recent examples of both genera



occur also (Fig. 2c); these are vertically elongated rather than expanded and flattened like polyodontid scutes, but resemble them to some degree (Fig. 2j-k).

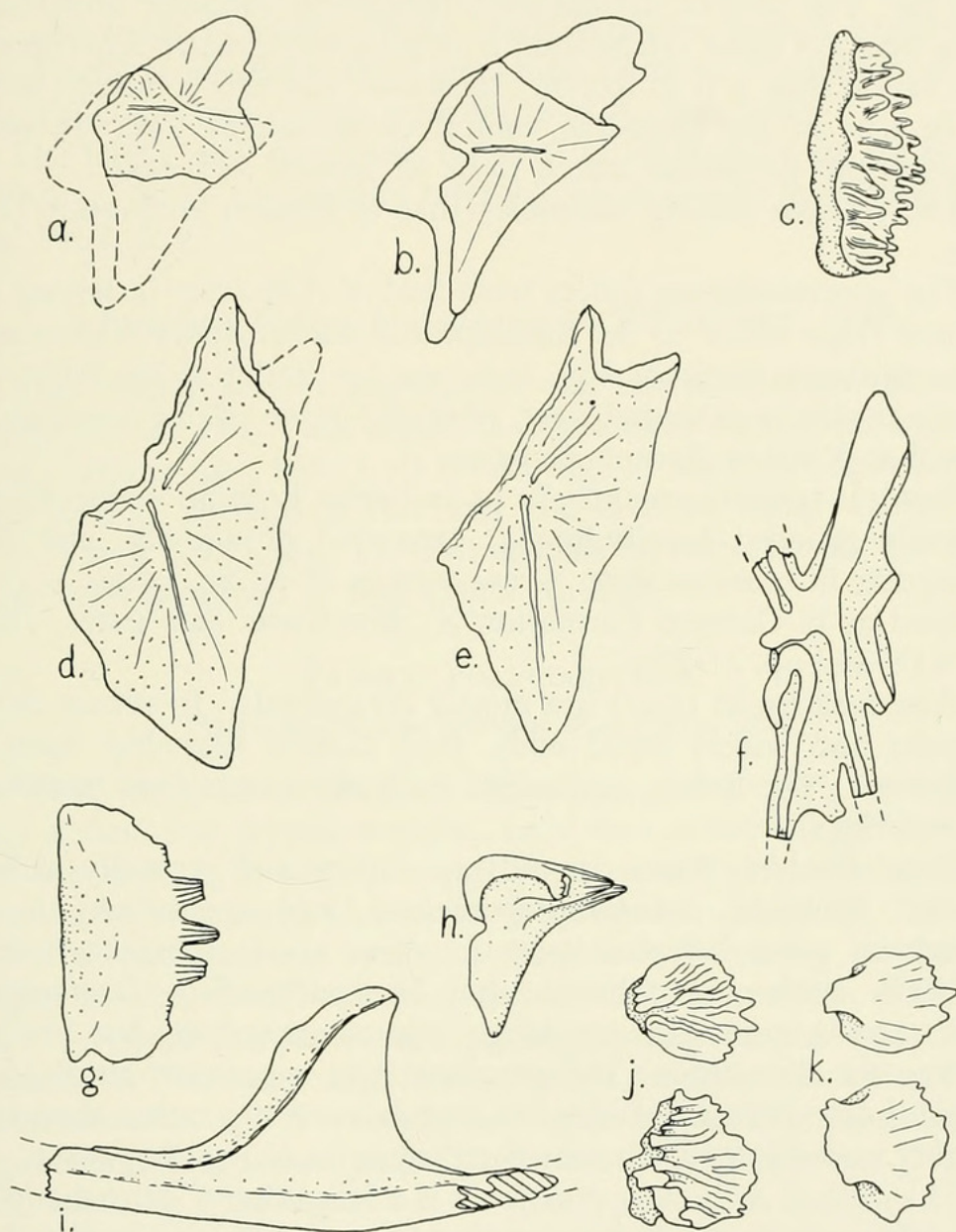


FIG. 2. a, *Acipenser eruciferus*, restored right supracleithrum, MCZ 9450,  $\times 1$ ; b, Recent *Acipenser* sp., the same,  $\times 0.5$ ; c, *A. eruciferus*, dermal scute, MCZ 9442; d, the same, left clavicle, MCZ 9448,  $\times 1.8$ ; e, Recent *Acipenser* sp., the same,  $\times 0.5$ ; f-k, *Paleopsephurus wilsoni*, f, rostral(?) scute, MCZ 9446,  $\times 1.8$ ; g, outer, and h, dorsal views of referred dermal denticle, MCZ 9445,  $\times 3$ ; i, dorsal view of left maxilla, MCZ 9332,  $\times 3$ ; j, outer, and k, inner views of two dermal denticles, MCZ 9445,  $\times 3$ ; a, c-d, f-k from Bug Creek Anthills, Hell Creek Formation, McCone County, Montana. Sculpture pattern indicated by coarse stipple on a-b, d-e.



The shoulder girdle elements resemble those of *Acipenser* more than those of *Scaphirhynchus*. The cleithrum is a powerful element with a complexly curved attachment area for the pectoral spine and fin. The area of dermal bone separating adductor attachment from pectoral spine articulation is of relatively greater anteroposterior extent than it is in Recent *Acipenser*, and this condition seems to be true of the plate-like ventral expansion as well. In other respects the specimens match those of Recent *Acipenser*.

The clavicle closely resembles that of Recent *Acipenser* (Fig. 2d).

The supracleithrum differs from that of *Acipenser* in having the dermal ridge closer to the unsculptured suprascapular-extrascapular articulation surface (Fig. 2a); one (or both) of the latter two bones evidently extended over relatively more of the supracleithrum than it did in Recent *Acipenser*.

Pectoral spine fragments are as in Lance Formation specimens: coarsely grooved longitudinally, expanded proximally, and subtriangular in cross-section. Cross-section of all fin spines is compressed as in Oldman Formation *A. albertensis* (see Estes, 1964, fig. 11b, and pp. 21-22).

Preserved hyoid bones are mostly ceratohyals. In robust development and widely-flared ends, they closely resemble those of *Acipenser*. The hollow, unossified ends show numerous transverse growth rings.

Dermal roofing bones are all fragmentary and generally undiagnostic. Parietals, dermosupraoccipitals, and operculum are referred on general resemblance to these same rather featureless bones in *Acipenser*, and some may be misidentified. Dermosphenic and supraorbital fragments are characteristic but are too broken for discussion. The pterotics have a posteroventral (hyomandibular-intercalary) ridge that ends centrally rather than continuing two-thirds of the way forward as in living *Acipenser*.

The type of *Acipenser eruciferus* is a fragment of dermal roofing bone from the Lance Formation that Cope (1876) believed to be a lungfish tooth plate. Estes (1964) referred similar Lance Formation material to *Acipenser*, as *A. eruciferus* (Cope), although the type is a *nomen vanum*. No nomenclatorial difficulties should be encountered unless articulated material should show that more than one species of *Acipenser* is present in the Lance Formation and that they are indistinguishable on the basis of dermal scute sculpture. In identifying material from other deposits, use of the name



*A. eruciferus* is less assured, yet the close temporal and geographical association of Lance and Hell Creek Formations lends some security to the reference. We prefer to continue using this name since the only other described species from the midcontinent is *A. albertensis* (Lambe, 1902), itself a *nomen nudum* based only on dermal scutes from the Campanian Oldman Formation of Alberta that are inseparable from those of *A. eruciferus*.

The Hell Creek specimens referred to *Rhineastes* sp. by Brown (1907, p. 842) are actually referable to *Acipenser eruciferus* (Estes, 1964, p. 21).

*Protoscapirhynchus squamosus* Wilimovsky, 1956

This poorly known acipenserid was described from the same locality in the Fort Peck region that produced *Paleopsephurus wilsoni* (Wilimovsky, 1956). It is thus high in the Hell Creek Formation section, perhaps at Harbicht Hill level or higher (Sloan and Van Valen, 1965, fig. 1). No specimens referable to this form have been identified at Bug Creek Anthills.

FAMILY POLYODONTIDAE

*Paleopsephurus wilsoni* MacAlpin, 1947

MCZ 9332, 9443-9447, maxillae, pterotics, frontal, rostral dermal scutes, and dermal denticles have been identified. The maxillae are distinctive bones, being flat externally and all bearing a prominent ectopterygoid process grooved dorsomedially (Fig. 2i). All five specimens are broken at both ends but direct comparison with the type specimen makes the identification clear. MacAlpin (1947) noted that the ectopterygoid process was present as a thin process in *Psephurus* and that a similar process was also present in *Saurichthys* and *Elonichthys*. Woodward (1895, pl. 1, fig. 3) figures an almost exactly similar process in *Chondrosteus* that was not noted by MacAlpin.

Frontal and pterotic match comparable elements in *Paleopsephurus*. Dermal sculpture on the frontal is much more prominent than on the pterotic. Both degrees of sculpture development occur on various parts of the type specimen and the variation is probably not significant.

Some dermal scutes are elongated, stellate, coarsely ridged, and thickened dorsally (Fig. 2f). We interpret these as rostral scutes because of their similarity to those of Recent paddlefish; they differ from the latter in being relatively less stellate, more robust, and



more anteroposteriorly elongated. These differences may indicate a rostrum proportioned more as in *Polyodon* than in *Psephurus*.

Trunk dermal denticles differ from those figured by MacAlpin in being flat-topped, and in having an attachment process almost at right angles to the body of the scute (Fig. 2j-k). Scute surfaces are coarsely striated and grooved, and the posterior borders are denticulated. One larger, less expanded scute (Fig. 2g-h) may be from near the shoulder girdle. Among scutes figured by MacAlpin (1947), those of *Crossopholis* are most like the Bug Creek specimens, but polyodontid dermal scute variability is great, and the total range is not known for *Paleopsephurus*, so that the variation may not be significant.

#### ORDER ASPIDORHYNCHIFORMES

##### Family Aspidorhynchidae

##### *Belonostomus longirostris* (Lambe, 1902)

MCZ 9333, a fragmentary predentary and a skull fragment, resemble Lance Formation specimens (Estes, 1964, p. 22).

#### ORDER AMIIFORMES

##### Family Amiidae

##### *Amia fragosa* (Jordan, 1927)

Large numbers of specimens of this species have been recovered (MCZ 9286-9293, 9390-9432), and have been reviewed by Estes and Berberian (1969), who substantiated Janot's (1967) suggestion that *Kindleia* is a synonym of *Amia*.

##### *Amia* ("Protamia") sp.

Two glassy, translucent tooth tips (MCZ 9334) are similar to those of Lance Formation specimens. No vertebrae or large skull elements occur in the large Bug Creek sample. Janot (1967) has suggested that *Protamia*, like *Kindleia*, is a synonym of *Amia*.

The presence of both small and large amiids is common in many late Mesozoic and early Cenozoic deposits both in Europe and in North America (Estes, 1964); careful study of this material would be of considerable systematic and zoogeographic interest.

#### ORDER AMIIFORMES?

##### Family Palaeolabridae

##### *Palaeolabrus montanensis* Estes, 1969h

This fish was described by Estes (1969h) on the basis of palatal tooth plates, skull and mandibular elements, and vertebrae. The



type species is from the late Paleocene or early Eocene Dormaal deposits in Belgium (Casier, 1967).

## ORDER LEPISOSTEIFORMES

### Family Lepisosteidae

#### *Lepisosteus occidentalis* Leidy, 1856

Almost all bones of skull and skeleton are present (MCZ 9354-9389).

Estes (1964) gave a restoration of this species, which is a wide-snouted form closely related to the living alligator gar *L. spatula*. The quadratojugal, found at Bug Creek but not in the Lance Formation sample, does not differ fundamentally from the same bone in *Lepisosteus spatula*.

The circumorbital series (incomplete in the Lance Formation sample) has been identified and shows no significant differences from that of Recent *Lepisosteus*.

## ORDER ELOPIFORMES

### SUBORDER ELOPOIDEI

#### Family Elopidae

Estes (1964, p. 48, fig. 23) described large teleost scales having a granular apical sculpture as resembling those of the late Cretaceous elopid *Dinelops*, from the English Chalk. Casier (1966, p. 133, pl. 13, fig. 3) described similar scales from the Eocene London Clay and referred them to an unknown elopid. Two scale fragments (MCZ 9338) are identical to the Lance Formation specimens but do not suggest any further clues as to the generic identity of the fish.

### SUBORDER ALBULOIDEI

#### Family Phyllodontidae

#### *cf. Paralbula casei* Estes, 1969a

MCZ 9335 consists of three teeth, two of which are superimposed phyllodont teeth; the other is a single tooth with the characteristic coarse tooth pattern of *Paralbula casei* (Estes, 1969a). The directly successional rather than the overlapped arrangement of the teeth indicates a phyllodontine rather than a paralbuline replacement (Estes, 1969a), but an occasional directly successional pair of teeth may occur in the latter group. The coarse surface sculpture and appearance of the isolated tooth are as in the type of *P. casei* (Estes, 1969a, fig. 3). *P. casei* is known from the Campanian of



Wyoming, Maestrichtian of New Jersey, and Eocene of England; this record constitutes the highest stratigraphic occurrence of the species in the Western Interior region of North America.

Family Albulidae  
*Coriops amnicolus* Estes, 1969h

These albuloid parasphenoid and basibranchial tooth plates (MCZ 9340) differ from those of *Albula* in having the teeth fused to the plates and in lacking otic articulation surfaces on the parasphenoid. *Coriops* also occurs in the Lance Formation (Estes, 1969h).

ORDER PERCIFORMES  
Family Sciaenidae  
*Platacodon nanus* Marsh, 1889

MCZ 9336, two fifth ceratobranchials; MCZ 9337, referred dentaries, maxillae, vertebrae, and other bones.

The fifth ceratobranchials are paired and have the characteristic tooth arrangement of this species as indicated by attachment areas (Estes, 1964, p. 51, fig. 25) although no teeth are preserved on these specimens. Referred skull elements, vertebrae, and spiny rays may belong to this species or may include other perciform types as well.

Teleostei *incertae sedis*

Numerous vertebrae and miscellaneous fragments of skull bones may indicate teleosts other than the five noted above, but they are not distinctive enough for identification.

CLASS AMPHIBIA  
ORDER CAUDATA  
SUBORDER AMBYSTOMATOIDEA  
Family Scapherpetontidae  
*Scapherpeton tectum* Cope, 1876

MCZ 3673. Vertebrae, atlantes, dentaries, maxillae, parietals, postdentary "compound" bones, and exoccipitals are preserved. Estes (1969b) referred both this genus and *Lisserpeton* to the Ambystomatoidea on the basis of fused postdentary "compound" bones, including fused prearticular and angular.



*Lisserpeton bairdi* Estes, 1965

MCZ 3674, 3677-3679. Vertebrae, atlantes, dentaries, maxillae, parietals, postdentary "compound" bones, and exoccipitals are preserved. Figures and descriptions of this relative of *Scapherpeton* are given in Estes (1965).

## Family Prosirenidae

*Prodesmodon copei* Estes, 1964

MCZ 3652, trunk vertebrae, are rare at Bug Creek Anthills, much rarer than in the Lance Formation. Reasons for referring this genus to the Prosirenidae are given in Estes (1969c).

## Family Batrachosauroididae

*Opisthotriton kayi* Auffenberg, 1961

MCZ 3676. Vertebrae, atlantes, dentaries, exoccipitals, parietals, premaxillae, and maxillae have been identified. Reasons for referring this genus to the Batrachosauroididae are given in Estes (1969b).

## SUBORDER SALAMANDROIDEA?

## Family Amphiumidae

*Proamphiuma cretacea* Estes, 1969e

This earliest amphiumid, represented only by vertebrae, has been described by Estes (1969e) from Bug Creek Anthills. It is probably ancestral to the Recent *Amphiuma*.

## SUBORDER MEANTES

## Family Sirenidae

*Habrosaurus dilatus* Gilmore, 1928

MCZ 3675. Vertebrae, atlantes, and dentaries are present, and are similar to Lance Formation specimens.

## ORDER SALIENTIA

## Family Discoglossidae

*Scotiophryne pustulosa* Estes, 1969f

This frog was described by Estes (1969f) on the basis of ilia, humeri, maxillae, and squamosals; the Recent Eurasian genus *Bombina* appears to be its closest relative.



cf. *Barbourula* sp.

MCZ 3653, a single right ilium, has a relatively large acetabular fossa with a prominent flare of the anterior border and a prominent iliac symphysis, as noted by Estes (1964, p. 55, fig. 56) in the Lance Formation specimens. Material described but not named by Hecht and Hoffstetter (1962) indicates that a European early Oligocene discoglossid also displays these characteristics. The European ilia are similar to Lance and Bug Creek specimens and may perhaps be placed in the same genus, which will be described in a paper now in preparation by Hecht and Hoffstetter.

#### Undescribed genus and species

Distinctive humeri known from only two specimens (MCZ 3654) have raised olecranon scars of rather limited proximal extent that are sharply demarcated by concave areas on either side. The humeral ball is relatively large and projects in lateral view. The medial epicondyle is blunt and is broken on both specimens; the lateral epicondyle is essentially undeveloped (Fig. 3).

These unusual humeri are referred to the Discoglossidae on the basis of the blunt, truncated medial epicondyle, the large and projecting ball, and the limited extent of the olecranon scar; these conditions resemble those of *Alytes*, an essentially fossorial discoglossid. Somewhat similar conditions also prevail in *Rhinophrynus*, also a burrower, although the detailed resemblance is with *Alytes*. Humeri referred to *Scotiophryne* are quite different (Estes, 1969f, fig. 3), and because of both the dissimilarity of the humeri and the very different adaptations in the Recent genera, it seems unlikely that the *Barbourula*-like ilium and these *Alytes*-like humeri are from the same taxon. The Bug Creek humeri are distinctive, but we can offer no further comment on their relationships at this time.

#### Family Pelobatidae?

##### *Eopelobates* sp. ?

Material questionably referred to the Pelobatidae by Estes (1964, figs. 30, 31c-e) and other specimens placed "near Hyliidae?" (1964, fig. 31a-b) are perhaps referable to a primitive species of *Eopelobates* on the basis of squamosal shape and sculpture similarities to a new Eocene pelobatid from North America (Estes, 1970, in press). Bug Creek material (MCZ 3655) includes several fragmentary maxillae, one fragmentary squamosal, and



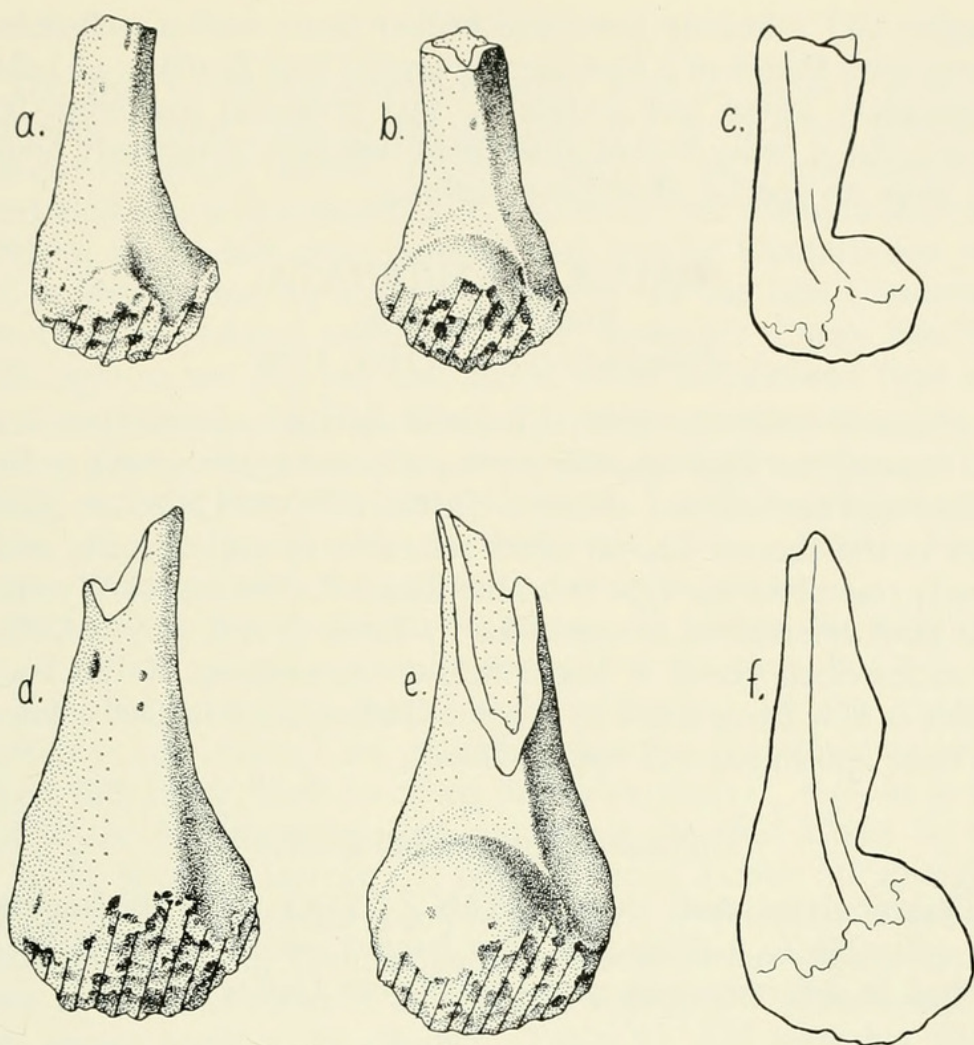


FIG. 3. Right humeri of undescribed genus and species of discoglossid; *a-c*, dorsal, ventral and anterior (outline) views of MCZ 3654a; *d-f*, the same, MCZ 3654b; Bug Creek Anthills, Hell Creek Formation, McCone County, Montana;  $\times 8$ ; cross-hatching indicates broken surface.

three ilia, all similar to the Lance Formation specimens. No further comment on these specimens is possible at this time.

#### Other Frog Remains

(1) Two maxillary fragments that lack external sculpture, have posterior processes indicating the presence of a complete maxillary arcade, and have teeth set in a relatively deep sulcus dentalis; (2) two humeri with medial, symmetrical olecranon scars that are of a type common in many of the advanced frog families; (3) one procoelous vertebra and two other badly worn and abraded frog vertebrae that are the only axial frog elements in the Bug Creek



sample; (4) a heavily worn and broken ilium with a well-defined dorsal crest that is of a type seen in several frog families; (5) three postdentary lower jaw fragments, two proximal radioulna fragments, and a badly broken tibiofibula that are distinctively anuran but have no special identifying features.

## ORDER TESTUDINATA

### Family Baenidae

#### *Eubaena cephalica* Hay, 1908

A nearly complete skull, fractured on the supraoccipital crest and missing the right maxillary area, is present, along with isolated cranial and mandibular elements (MCZ 3510-3512, 3519, 3530). This is the second known skull referable to this species, and it closely resembles the type from the Lance Formation of Wyoming. The skull referred to *E. cephalica* by Estes (1964, p. 97) belongs to undescribed genus 1 noted below. A revision of the baenid turtles is now being made by Eugene Gaffney, and further comment on these specimens will appear there.

#### Undescribed genus and species 1

Disarticulated skull elements (MCZ 3514) and shell fragments are referable to a distinctive new baenid genus, and will be described in a forthcoming study by Eugene Gaffney.

#### Undescribed genus and species 2

Another new genus of baenid turtle occurs in the Bug Creek sample and is represented only by isolated maxillae (MCZ 3515-3518). It differs from both *Eubaena* and the other undescribed baenid in having an exceptionally wide maxillary triturating surface without a ridge. These specimens will also be described by Eugene Gaffney, on the basis of more complete material from the Paleocene of Wyoming.

### Family Dermatemydidae

#### *Compsemys victa* Leidy, 1856

MCZ 3671, numerous shell fragments, have the characteristic sculpture pattern of many closely-set, flat-topped pustulae seen in all described species of this genus. *C. victa* occurs in the Lance Formation of Wyoming, and the Bug Creek specimens probably belong to this species.



*Adocus* sp.

The Bug Creek specimens referred here all have a very fine sculpture (about eight to ten pits per cm) as in some species of *Adocus* (Gilmore, 1919). Brown (1907; p. 842) originally identified Hell Creek specimens as *A. lineolatus*, but Gilmore indicated (1919), p. 25 and other papers) that specific identification cannot be determined by sculpture pattern. In the late Cretaceous, two types of *Adocus* sculpture occur, however: a very fine type with eight to ten pits per cm, and a more well-defined type with six to seven pits. All Hell Creek Formation specimens are in the former group suggesting that these two sculpture types are not simply variants from different shell areas. Lance Formation specimens are clearly referable to *Basilemys* (Estes, 1964), having coarse sculpture with only three to four pits per cm.

Because too few specimens of *Adocus* are known, the validity of the described species cannot be assessed at this time, but it is safe to say that more are named than is justified by the material. *Basilemys* and *Adocus* are probably quite closely related (as compared with other fossil so-called dermatemydids). *Adocus* is limited to the Maestrichtian and occurs on the East Coast as well as in the Western Interior. It is primitive in having inframarginal shields and unexpanded pectoral shields. *Basilemys*, which extends through both Campanian and Maestrichtian stages, has not gone as far as *Adocus* in neural and suprapygal reduction. The two genera seem to be distinct (Table 2) and probably had a common ancestor in pre-Campanian time.

TABLE 2

Comparison of characters separating *Adocus* and *Basilemys*

<i>Adocus</i>	<i>Basilemys</i>
1. Inframarginals large, extending across bridge.	1. Tiny axillary and inguinal inframarginals (except <i>B. nobilis</i> ).
2. A single suprapygal; posterior neurals reduced.	2. Two or three suprapygals; posterior neurals unreduced (except <i>B. nobilis</i> ?)
3. Posterior marginal shields large, elongated anteroposteriorly.	3. Posterior marginal shields narrow, elongated mediolaterally.
4. Plastral lobes rounded.	4. Plastral lobes tend to be acute.



- |  |  |
|--|--|
| 5. Pectoral shields little expanded medially.                          | 5. Pectoral shields greatly expanded medially.                             |
| 6. Sculpture relatively smooth and fine, about six to ten pits per cm. | 6. Sculpture relatively rough and coarse; about three to four pits per cm. |
| 7. Carapace length 480-670 mm.   | 7. Carapace length 690-940 mm.   |

Family Testudinidae  
Subfamily Emydinae?  
Unidentified genus and species

Fragmentary eighth cervical vertebrae (MCZ 3567-3568, 3573) have a double concave articulation surface posteriorly. Numerous fragments of peripherals (MCZ 3656) and costals (MCZ 3657) show deeply impressed shield sulci and marked changes in elevation between the shield areas.

Double, concave articulation surfaces on the eighth cervical vertebra are known only in the Testudinidae (Williams, 1950). The fragments of carapace and plastron closely resemble the shells of pond turtles, especially *Pseudemys*. The questionable family reference given by Estes (1964, p. 99) to similar specimens from the Lance Formation is confirmed by the distinctive cervical vertebrae present here. This is the earliest record of the family, otherwise not known before the Eocene *Echmatemys*; it will be discussed further in a study in preparation.

Family Trionychidae  
*Trionyx* sp.

A partial left hypoplastron (MCZ 3658) and many costal and neural fragments (MCZ 3672) all bear a characteristic trionychid sculpture. The hypoplastron shows that the plastron was reduced, indicating that the specimen cannot be referred to the line of fossil trionychids often designated as *Plastomenus*. The presence or absence of a prenuchal bone cannot be demonstrated in this material, but recent work (Webb, 1962) indicates that the presence of a prenuchal is insufficient ground for separating the genus *Aspideretes*. It thus seems best to refer this material to *Trionyx* (s. l.) as well as the material referred to *Aspideretes beecheri* by Estes (1964).



CLASS REPTILIA  
ORDER EOSUCHIA  
Family Champsosauridae  
*Champsosaurus* sp.

MCZ 3651, ten vertebrae, a few tooth crowns, and three ribs are present. The specimens are clearly referable to this genus but are specifically indeterminable. *Champsosaurus* was evidently rare at Bug Creek Anthills, and is represented only by small individuals.

ORDER SAURIA  
SUBORDER SCINCOMORPHA  
Family Teiidae  
*Chamops segnis* Marsh, 1892

MCZ 3659, dentary fragments, fragment of left maxilla, four unnumbered tooth-bearing fragments; MCZ 3660, fragmentary parietals. These specimens were originally cited by Estes (1964, p. 108) as possibly forming a new species of *Chamops* because Bug Creek specimens available at that time all seemed to show less bulbous tooth bases than did Lance Formation fossils. Subsequently collected Bug Creek specimens do not bear out this distinction. *Chamops* most closely resembles the Recent South American species *Callopiastes maculatus* (Estes, 1969d).

*Leptochoamops denticulatus* (Gilmore, 1928)

MCZ 3661, two maxillae and a few tooth-bearing fragments, are poorly preserved but appear to belong to this species.

*Haptosphenus placodon* Estes, 1964

MCZ 3686, fused right dentary and splenial and a coronoid with adhering parts of fused dentary and surangular are preserved. The dentary shows the short, heavy jaw; short, rather *Chamops*-like teeth; and fused postdentary bones with visible suture lines as in Lance specimens. *Haptosphenus* is aberrant in the fusion of jaw elements; we do not know of a comparable situation in lizards. Nevertheless the closest resemblances of *Haptosphenus* seem to be with *Chamops*, differing from the latter both in bone fusion and in having almost acrodont teeth; it may be an aberrant teiid derived from a *Chamops*-like ancestor.



*Peneteius aquilonius* Estes, 1969d

This lizard was described by Estes (1969d); it shows resemblances both to the Recent *Teius* and *Dicrodon* as well as to the late Cretaceous *Polyglyphanodon*. The holotype is the unique specimen.

Family Scincidae ?

*Contogenys sloani* Estes, 1969g

This lizard was described by Estes (1969g). *Contogenys* resembles members of the Scincidae; although it is not clearly referable to that family, it is certainly a member of the Scincoidea.

Family Anguidae

*Pancelosaurus piger* (Gilmore, 1928)

This species was described in detail and removed from *Peltosaurus* by Meszoely (1970), who, in his revision of the Anguidae, placed *Pancelosaurus* at the base of the subfamily Anguinae rather than in the Gerrhonotinae as suggested by Estes (1964).

Family Xenosauridae

*Exostinus lancensis* Gilmore, 1928

A number of dentary and maxillary fragments and a referred frontal are present. The jaw elements (MCZ 3662a) do not differ significantly from Lance Formation specimens of this species. The frontal (MCZ 3662b) may be referable to *E. lancensis* on the basis of dermal sculpture pattern. It is eroded, and because of this and its small size, it does not display a sculpture pattern as well developed as that on the larger Lance Formation parietal referred by Estes (1964, pl. 3). If properly referred, frontals were paired in *E. lancensis*, a condition that, while different from that in later species of *Exostinus* and from *Xenosaurus* itself, is not a surprising one in view of its Cretaceous age.

*Diploglossa incertae sedis*

*Colpodontosaurus cracens* Estes, 1964

Well-worn fragments of dentaries and maxillae (MCZ 3663) lack teeth except in one specimen.

Estes (1964, p. 127) placed *Colpodontosaurus* as *Diploglossa incertae sedis* on the basis of a tiny free ventral border of the intramandibular septum, the presumed lack of jaw hinge, and the



absence of basal fluting on teeth. Teeth on the type specimen have been broken since the original figure (1964, fig. 60) was made, and these fresh break surfaces show an irregular, almost fluted appearance; under high magnification, several faint grooves occur on the teeth of UCMP 49938, a maxilla from the Lance Formation.

Although a tiny free ventral border is present on the intramandibular septum, it is little different from that of *Varanus* and *Parasaniwa*. Reexamination of the type of *Colpodontosaurus* indicates that the presence or absence of a jaw hinge in this specimen cannot be determined, although the dentary seems to have a relatively greater posterior projection than it does in *Parasaniwa*.

On the maxillary fragments, the posterior end shows elongation of the posterior external mental foramina as in *Parasaniwa* and varanids. The dorsal border of the bone is elongated and gently sloping as in *Parasaniwa* and the anguids.

Absence of sculpture, delicate construction, condition of intramandibular septum, and elongated mental foramina are all as in varanids, and the last two characters show parasaniwid resemblances as well. The essential absence of basal infolding of teeth, and the long, slender, posterior process of the maxilla are characters suggesting diploglossans. The latter character is completely unlike that in *Varanus*, *Saniwa* and parasaniwids in indicating that the tooth row extended posteriorly well under the orbit.

Although new interpretation and new specimens have shown some varanid and parasaniwid characters, there are enough detailed differences to maintain *Colpodontosaurus* as *Diploglossa incertae sedis*.

#### Family Parasaniwidae

##### *Parasaniwa wyomingensis* Gilmore, 1928

A few dentary and maxillary fragments and a parietal (MCZ 3664) show the characteristic simple infolding of tooth bases, fused intramandibular septum and sculptured skull roof of topotypic material from the Lance Formation.

##### *Paraderma bogerti* Estes, 1964

A fragmentary left maxilla, an isolated tooth with adherent jaw fragment and two referred vertebrae (MCZ 3687) do not differ from Lance Formation specimens.



## INFRAORDER PLATYNOTA

## Family Varanidae

*Palaeosaniwa*, cf. *P. canadensis* Gilmore, 1928

Only a single large varanid vertebra occurs in the Bug Creek sample (MCZ 3665), and it differs from Lance Formation specimens in having less well-developed zygosphenes. The Bug Creek specimen is about the size of the type (from the Campanian Oldman Formation of Canada), and has convex lateral borders of the centrum, as do Eocene *Saniwa* and both Oldman Formation and Lance Formation *Palaeosaniwa*.

## ORDER SAURIA ?

Family *incertae sedis*

*Cuttysarkus mcnallyi* Estes, 1964

Three dentaries (MCZ 3666) show no significant differences from the Lance Formation specimens. The systematic position of this genus is even less clear now than when discussed by Estes (1964). Nearly forty dentaries are known from the Lance Formation type area, but no maxillary fragments of this distinctive animal were discovered.

A number of people have commented on relationships of *Cuttysarkus*, and have offered possibilities spanning all lower vertebrate Classes. One colleague suggested that the name was based on arthropod mandibles, yet we must reject his contribution by noting that *Cuttysarkus* jaws are composed of characteristic, cellular vertebrate bone. One of the most reasonable possibilities came from C. Wilson Kerfoot, who suggested that there were many similarities between the dentaries of *Cuttysarkus* and the salamander *Opisthotriton*. Absence of a sulcus dentalis, lack of definition of Meckelian groove, straight posterior border of the dentary and posteroventral depression lingually are all indicative of salamander dentary structure, although each of these features can be matched in one or another lizard group. The teeth are not pedicellate but this condition can be matched in the salamanders *Prodesmodon* and *Habrosaurus*. The absence of maxillae could be interpreted as evidence that *Cuttysarkus* was a larval salamander. Yet all Lance and Hell Creek Formation salamanders are distinctive, and most are essentially of "larval" or paedomorphic type (Estes, 1964). *Cuttysarkus* jaws are too distinctive themselves, in any case, to be from larvae of any of the salamanders present. In the Lance Formation, each known type of salamander vertebrae



is matched by distinctive skull elements consonant with the vertebrae in size, morphology, state of preservation, and frequency of occurrence. Mandibular elements of *Proamphiuma* (Estes, 1969e) are unknown, but there is no resemblance of *Cuttysarkus* to *Amphiuma* in maxillary structure. *Cuttysarkus* may not be a lizard, but we retain it there for the present.

ORDER SERPENTES  
SUPERFAMILY BOOIDEA

Family Aniliidae

*Coniophis precedens* Marsh, 1892

Only a few vertebrae are present (MCZ 3667) and indicate no difference from Lance Formation specimens (Estes, 1964; Hecht, 1959). A pair of coossified frontals (MCZ 3668) is also referred; no comparisons are made at this time pending study of other *Coniophis* material by Hecht.

Family Boidae

Subfamily Erycinae ?

Unidentified genus and species

A single vertebra (MCZ 3669) is poorly preserved and broken but is of interest in demonstrating the presence of a second species of snake from the Cretaceous of North America (Fig. 4). Centrum length (CL, Auffenberg, 1963, fig. 3) is 8.8 mm, about the size of some Eocene *Boavus* vertebrae but twice as large as the largest known *Coniophis* specimen. In having a condylar ball with rather sessile edges, sessile haemal carina and paradiapophyses, and a compact centrum shape, this specimen resembles vertebrae of the subfamily Erycinae (*sensu* Hoffstetter, 1955) rather than those of the Boinae. Erycines have previously not been reported before the Eocene (Hecht, 1959). Without characters of the neural arch, this specimen cannot be identified more specifically.

ORDER CROCODILIA  
SUBORDER EUSUCHIA

Family Crocodylidae

Subfamily Crocodylinae

*Leidyosuchus sternbergi* Gilmore, 1910

Many crocodile teeth (MCZ 3648) occur in the Bug Creek sample and, on the basis of shape and general appearance, are similar to those of the type specimen and referred Lance Formation material (Estes, 1964).



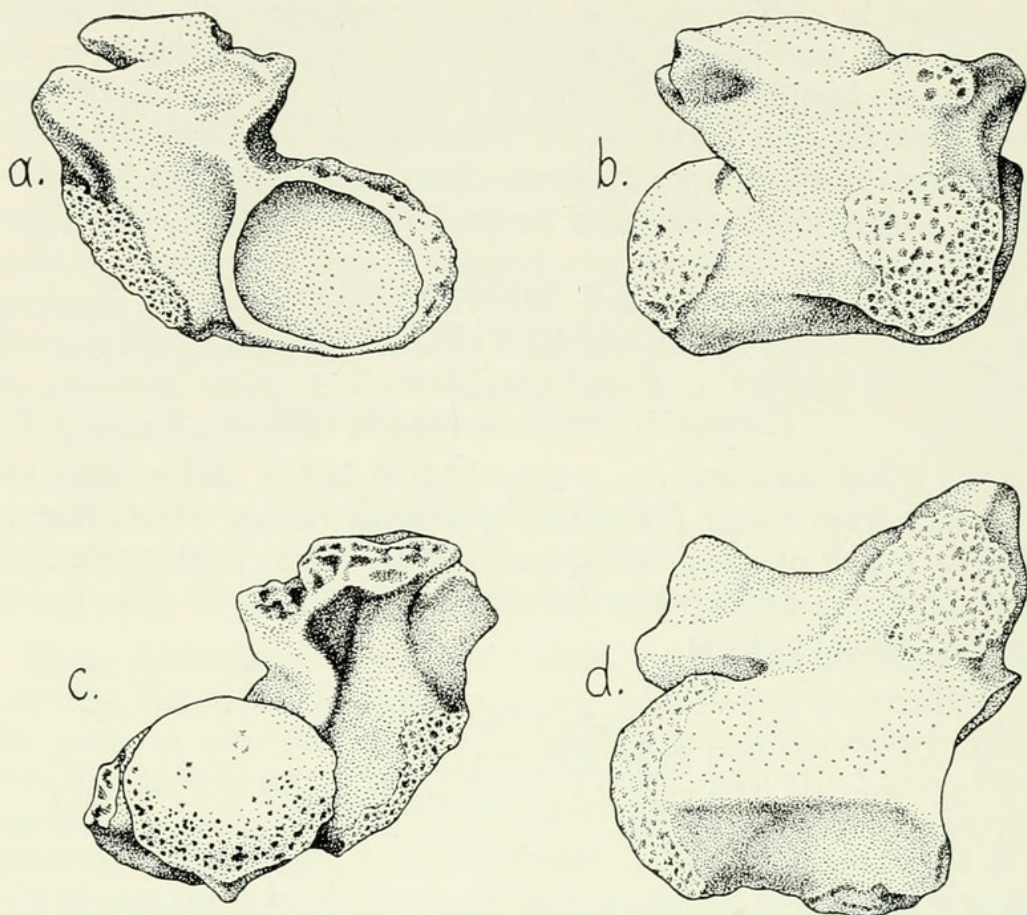


FIG. 4. Vertebra of boid snake, MCZ 3669; *a*, anterior, *b*, lateral, *c*, posterior, and *d*, ventral views; Bug Creek Anthills, Hell Creek Formation, McCone County, Montana;  $\times 4$ .

#### Subfamily Alligatorinae

#### *Brachychampsia montana* Gilmore, 1911

Bulbous, low-crowned teeth (MCZ 3650), scutes, fragmentary limb, vertebral and skull bones are relatively common. The teeth are relatively smaller than those of the type specimen, which is also from the Hell Creek Formation of Montana. Some of the skull and skeletal fragments referred here probably belong to *Leidyosuchus*.

#### ORDER SAURISCHIA SUBORDER THEROPODA INFRAORDER COELUROSAURIA

#### Family Coeluridae ?

#### Unidentified genus and species

These delicate teeth (MCZ 3694) are serrated only on their posterior borders and are rare at Bug Creek Anthills. Estes (1964)



noted that similar Lance teeth with fine serrations resembled those of *Velociraptor*, but in shape and size they resemble those of other coelurids as well, including the Oldman Formation *Chirostenotes* and the Triassic *Coelophysis*. Generic identifications cannot be based on teeth of this sort (Pl. 1b).

*Paronychodon lacustris* Cope, 1876

A few teeth (MCZ 3645) of this peculiar type occur in the Bug Creek sample (Pl. 1d). *Paronychodon* teeth have been figured several times, most recently by Russell (1935, pl. 2, fig. 8). The flattened lingual side may indicate an anterior tooth; other referred specimens with the same coarse striations (Pl. 1e) lack the flattened side and may be from the posterior part of the tooth row. The Bug Creek specimens appear to be unworn, and are unserrated; Lance Formation and Judith River Formation specimens may be either serrated or unserrated.

Theropoda? *incertae sedis*

A few teeth (MCZ 3680) of the straight-sided type figured by Estes (1964, fig. 69b) occur in the Bug Creek material.

INFRAORDER DEINONYCHOSAURIA ?

Family Dromaeosauridae ?

These short-crowned, sharply recurved teeth have about 40 serrations per 5 mm anteriorly, 30 posteriorly. They are of the same tooth type as those described by Cope as *Laelaps*, from the Judith River Formation of Montana. The Bug Creek specimens (MCZ 3695, Pl. 1C) are the smallest teeth of this type that we have seen, although several Lance Formation specimens approach them in size.

*Laelaps* is often included in *Dryptosaurus*, and Lance Formation specimens of the *Laelaps* type were questionably referred to *Dryptosaurus* by Estes (1964). The recent revision of Colbert and Russell (1969) suggests that *Laelaps* might better be included with the dromaeosaurs. Generic reference of this type of teeth, however, is difficult; the teeth from Bug Creek Anthills do not fall within any of the ranges of tooth serration number outlined by Colbert and Russell (1969, pp. 39-40). Sloan (1969, pers. comm.) found *Gorgosaurus* in other Bug Creek localities (Bug Creek West, Harbicht Hill), but its teeth are larger than any of the above.



ORDER ORNITHISCHIA  
SUBORDER ORNITHOPODA

Family Hypsilophodontidae  
*Thescelosaurus neglectus* Gilmore, 1913

A few teeth (MCZ 3649) resemble teeth of this species (see Sternberg, 1940, p. 483, figs. 1-8).

Family Pachycephalosauridae ?

Several teeth (MCZ 3729) are obtuse, with little development of a cingulum (Pl. 1A), and may belong to this family.

Family Hadrosauridae  
*Anatosaurus* sp.

These teeth (MCZ 3646) are relatively common (for dinosaur teeth) in the Bug Creek sample and, in general, are somewhat smaller than most specimens from the Lance Formation. Most of the specimens appear to be heavily-worn teeth shed in replacement.

SUBORDER CERATOPSIA

Family Ceratopsidae  
*Triceratops* sp.

As for *Anatosaurus*, the teeth referred here (MCZ 3647) are relatively common, smaller in general than most Lance Formation specimens, and are heavily worn, shed in replacement.

CONCLUSIONS

The striking feature of the lower vertebrate faunal list from Bug Creek Anthills (BCA) described here is its similarity to that from localities in the Lance Formation of Wyoming, especially University of California locality V5620 (Estes, 1964), as shown in Table 1. Mammals are excluded so that direct comparison of the lower vertebrates can be made. The taxonomic similarity is supplemented by a broad similarity of relative abundance of genera in the two localities; holosteans, salamanders, and lizards are the most common groups at both sites. Rather significant differences in the relative abundance of individual species occur, however, and may be ecological in origin; these differences will be discussed in more detail in Estes and Berberian (in press), and the mammalian



species included, but some general comments may be made now.

The diminished abundance, diversity and specimen size of the sharks at Bug Creek Anthills relative to those of V5620 probably indicates that BCA had reduced access to marine conditions. Turtles and lizards, also common at V5620, are again poorer in diversity, abundance, and preservation at BCA. Since the presumably more active, free-swimming salamanders and bony fishes are diverse, abundant, and well preserved at BCA, it is probable that a riparian habitat supporting the lizards and turtles was less accessible. The relative number of specimens and the specimen size of dinosaur material is less at BCA than at V5620; whether this condition is the result of depositional environment or is a reflection of the imminent extinction of the group is unknown, but the latter possibility is the more probable. Although further analysis may disprove this, we suggest that the vertebrate fossils at BCA were deposited in the larger, more open waterways of the floodplain, and that the site of deposition was farther from the adjacent shores, than it was at V5620. Sloan and Van Valen (1965) came to rather similar conclusions based on analysis of the mammalian fauna, and have expressed the faunal differences among the various Hell Creek Formation localities in terms of the proximal and distal community concept of Shotwell (1955).

Some mammals from Bug Creek Anthills are different from those of the Lance Formation localities and indicate a "Paleocene aspect," according to Sloan and Van Valen (1965). As noted above, the non-mammalian fauna of BCA differs little from that of the Lance. The additional taxa at BCA may be grouped into three categories: (1) Unique records, (2) Forms previously known only from the Paleogene, and (3) Records of taxa already known from both Cretaceous and Tertiary deposits but not occurring in the Lance Formation. The unique forms include the boid snake, the teiid lizard *Peneteius*, and the amphiumid salamander *Proamphiuma*. As these animals are representatives of living families and are related to modern genera, with the possible exception of the boid, it might be said that they are representative of an "advanced" element in the faunule. Since their stratigraphic ranges are unknown, however, this group does not specifically indicate a "Paleocene aspect." Only two taxa compose the second group. *Palaeolabrus*, a fish otherwise known only from a single Paleogene locality in Belgium, is a poor indicator of the Paleocene affinity of the BCA lower vertebrate fauna. One of the undescribed baenid turtles is known from middle Paleocene specimens from



Wyoming; this is its first Cretaceous record. Again, it is a rare form and a poor indicator of Paleocene relationships. The third group includes the fish *cf. Paralbula*, the frog *Scotiophryne*, and the turtle *Adocus*. These taxa are known from other Cretaceous and Paleocene deposits in North America, although they do not occur in the Lance Formation, and thus do not indicate "a Paleocene aspect" for the fauna. *Adocus*, apparently an advanced derivative of the late Cretaceous *Basilemys*, is most similar to specimens of *Adocus* from the Arapahoe Formation of Colorado, which, like the Hell Creek Formation, is of late Cretaceous age (Weimer, 1960, fig. 2).

We therefore conclude that the faunal differences between Bug Creek Anthills and V5620 localities indicate mainly minor ecological differences, and that there is little evidence for a significant difference in age or faunal type between the two sites. The geographic position of the Hell Creek localities, the unique character of the mammalian fauna, and the presence of lower vertebrates absent in the Lance Formation, probably indicate that, during late Cretaceous time, the Bug Creek Anthills fauna was more closely associated with a northern, perhaps climatically more temperate, aspect of the floodplain fauna of the Western Interior of North America.

Connections to a marine environment were less available at BCA than at V5620 as indicated by the reduced shark fauna. Since the Bearpaw Sea was regressing southeastward at latest Cretaceous time (Weimer, 1960), it may have been closer to V5620 than to BCA. It is also possible that the difference in access to marine conditions was only the result of local conditions, and that geographically, the actual sea was approximately equidistant from both localities; no evidence as to the actual geographic position of the strandline is available for latest Cretaceous time, however.

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#### LITERATURE CITED

AUFFENBERG, W.

- 1961. A new genus of fossil salamander from North America. *Amer. Midl. Nat.*, **66**: 456-465.
- 1963. The fossil snakes of Florida. *Tulane Studies Zool.*, **10**: 131-216.

BROWN, B.

- 1907. The Hell Creek beds of the Upper Cretaceous of Montana: Their relation to contiguous deposits, with faunal and floral lists and a discussion of their correlation. *Bull. Amer. Mus. Nat. Hist.* **23**: 823-845.

CASIER, E.

- 1966. Faune ichthyologique du London Clay. British Museum (Nat. Hist.), Text + atlas; xiv + 496 pp.
- 1967. Le Landénien de Dormaal (Brabant) et sa faune ichthyologique. *Mem. Inst. Roy. Sci. Nat. Belgique*, **156**: 1-66.

COLBERT, E., AND D. RUSSELL

- 1969. The small Cretaceous dinosaur *Dromaeosaurus*. *Amer. Mus. Nat. Hist.*, Novit. No. **2380**: 1-49.

COPE, E.

- 1876. On some extinct reptiles and batrachians from the Judith River and Fox Hills beds of Montana. *Proc. Acad. Nat. Sci. Phila.*, **1876**: 340-359.

ESTES, R.

- 1964. Fossil vertebrates from the late Cretaceous Lance Formation, eastern Wyoming. *Univ. Calif. Publ. Dept. Geol. Sci.*, **49**: 1-180.



1965. A new fossil salamander from Montana and Wyoming. *Copeia*, **1965**, No. 1:90-95.
- 1969a. Studies on fossil phyllodont fishes: Interrelationships and evolution in the Phyllodontidae (Albuloidei). *Copeia*, **1969**, No. 2:317-331.
- 1969b. The Batrachosauroididae and Scapherpetontidae, late Cretaceous and early Cenozoic salamanders. *Copeia*, **1969**, No. 2: 225-234.
- 1969c. Prosirenidae, a new family of fossil salamanders. *Nature* (London), **224**: 87-88.
- 1969d. Relationships of two Cretaceous lizards (Sauria, Teiidae). *Mus. Comp. Zool., Harvard Univ., Breviora* **317**: 1-8.
- 1969e. The fossil record of amphiumid salamanders. *Mus. Comp. Zool., Harvard Univ., Breviora* **322**: 1-11.
- 1969f. A new fossil discoglossid frog from Montana and Wyoming. *Mus. Comp. Zool., Harvard Univ., Breviora* **328**: 1-7.
- 1969g. A scincoid lizard from the Cretaceous and Paleocene of Montana. *Mus. Comp. Zool., Harvard Univ., Breviora* **331**: 1-9.
- 1969h. Two new late Cretaceous fishes from Montana and Wyoming. *Mus. Comp. Zool., Harvard Univ., Breviora* **335**: 1-15.
1970. New fossil pelobatid frogs and a review of the genus *Eopelobates*. *Bull. Mus. Comp. Zool., Harvard Univ.* In Press.
- ESTES, R., AND P. BERBERIAN
1969. *Amia* (= *Kindleia*) *fragosa* (Jordan), a Cretaceous amiid fish, with notes on related forms. *Mus. Comp. Zool., Harvard Univ., Breviora* **329**: 1-14.
- In press. Paleoecology of a late Cretaceous vertebrate community from Montana. *Mus. Comp. Zool., Harvard Univ., Breviora* 343.
- GILMORE, C.
1910. *Leidyosuchus sternbergii*, a new species of crocodile from the *Ceratops* beds of Wyoming. *Proc. U. S. Nation. Mus.*, **38**: 485-502.
1911. A new fossil alligator from the Hell Creek beds of Montana. *Proc. U. S. Nation. Mus.*, **41**: 297-302.
1913. A new dinosaur from the Lance Formation of Wyoming. *Smithson. Misc. Coll.*, **61**: 1-5.
1919. Reptilian faunas of the Torrejon, Puerco, and underlying Upper Cretaceous formations of San Juan County, New Mexico. *U. S. Geol. Surv. Profess. Pap.* **119**: 1-68.
1928. Fossil lizards of North America. *Mem. Nat. Acad. Sci.*, **22**: ix + 201 pp.
- GREGORY, W.
1933. Fish skulls: a study of the evolution of natural mechanisms. *Trans. Amer. Philos. Soc.*, **23**: 75-481.
- HAY, O.
1908. The fossil turtles of North America. *Carnegie Inst. Washington, Publ.* **75**: iv + 568 pp.



HECHT, M.

1959. Reptiles and Amphibians. In: P. McGrew, The geology and paleontology of the Elk Mountain and Tabernacle Butte area, Wyoming. Bull. Amer. Mus. Nat. Hist., **119**: 121-176.

HECHT, M., AND R. HOFFSTETTER

1962. Note préliminaire sur les amphibiens et les squamates du Landénien supérieur et du Tongrien de Belgique. Inst. Roy. Sci. Nat. Belgique, **38**: 1-30.

HOFFSTETTER, R.

1955. Squamates de type moderne. In: J. Piveteau, Traité de Paléontologie. Paris: Masson et Cie., **5**: 606-662.

JANOT, C.

1967. À propos des amiïdes actuels et fossiles. Colloq. Intern. C. N. R. S., **163**: 139-153.

JORDAN, D.

1927. *Kindleia*, a new genus of cichlid fishes from the Upper Cretaceous of Alberta. Canad. Field Nat., **41**: 145-147.

LAMBE, L.

1902. New genera and species from the Belly River series (mid-Cretaceous). Contr. Canad. Paleon., **3**: 25-81.

LANGSTON, W.

1956. The shell of *Basilemys varialosa* (Cope). Ann. Rept. Nat. Mus. Canada, **142**: 155-165.

LEIDY, J.

1856. Notice of remains of extinct reptiles and fishes, discovered by Dr. F. V. Hayden in the Bad Lands of the Judith River, Nebraska Territory. Proc. Acad. Nat. Sci. Philadelphia, **1856**: 72-73.

MACALPIN, A.

1947. *Paleopsephurus wilsoni*, a new polyodontid fish from the Upper Cretaceous of Montana, with a discussion of allied fish, living and fossil. Cont. Mus. Paleon., Univ. Michigan, **6**: 167-234.

MARSH, O.

1889. Discovery of Cretaceous Mammalia, part 2. Amer. Jour. Sci., Ser. 3, **38**: 177-180.  
1892. Notice of new reptiles from the Laramie Formation. Amer. Jour. Sci., Ser. 3, **43**: 449-453.

MESZOELY, C.

1970. North American fossil anguid lizards. Bull. Mus. Comp. Zool., Harvard Univ., in press.

PATTERSON, C.

1966. British Wealden Sharks. Bull. British Museum (Nat. Hist.), Geol., **11**: 283-350.

RUSSELL, L.

1935. Fauna of the Upper Milk River beds, Southern Alberta. Trans. Roy. Soc. Canada, Ser. 3, **29**: 115-127.



## SHOTWELL, J.

1955. An approach to the paleoecology of mammals. *Ecology*, **36**: 327-337.

1958. Intercommunity relationships in Hemphillian (mid-Pliocene) mammals. *Ecology*, **39**: 271-282.

## SLAUGHTER, B., AND M. STEINER

1968. Notes on rostral teeth of ganopristine sawfishes, with special reference to Texas material. *Jour. Paleon.*, **42**: 233-239.

## SLOAN, R., AND L. VAN VALEN

1965. Cretaceous mammals from Montana. *Science*, **148**: 220-227.

## STERNBERG, C.

1940. *Thescelosaurus edmontonensis*, n. sp., and classification of the Hypsilophodontidae. *Jour. Paleon.*, **14**: 481-494.

## STROMER, E., AND W. WEILER

1930. Ergebnisse der Forschungsreisen Prof. E. Stromers in den Wuesten Aegyptens. VI: Beschreibung von Wirbeltier-Resten aus dem nubischen Sandsteine Oberaegyptens und aus aegyptischen Phosphaten nebst Bemerkungen ueber die Geologie der Umgegend von Mahamid in Oberaegypten. *Abh. Bay. Akad. Wiss. München, (N. F.)* **7**: 1-42.

## WEBB, R.

1962. North American Recent soft-shelled turtles (family Trionychidae). *Univ. Kansas Publ. Mus. Nat. Hist.*, **13**: 429-611.

## WEIMER, R.

1960. Upper Cretaceous stratigraphy, Rocky Mountain Area. *Bull. Amer. Assoc. Petrol. Geol.*, **44**: 1-20.

## WILIMOVSKY, N.

1956. *Protoscaphirhynchus squamosus*, a new sturgeon from the Upper Cretaceous of Montana. *Jour. Paleon.* **30**: 1205-1208.

## WILLIAMS, E.

1950. Variation and selection in the cervical central articulations of living turtles. *Bull. Amer. Mus. Nat. Hist.*, **94**: 511-561.

## WOODWARD, A.

1895. Catalogue of the Fossil fishes in the British Museum, Part 3. London, xliii + 544 pp.

(Received 22 August 1969.)



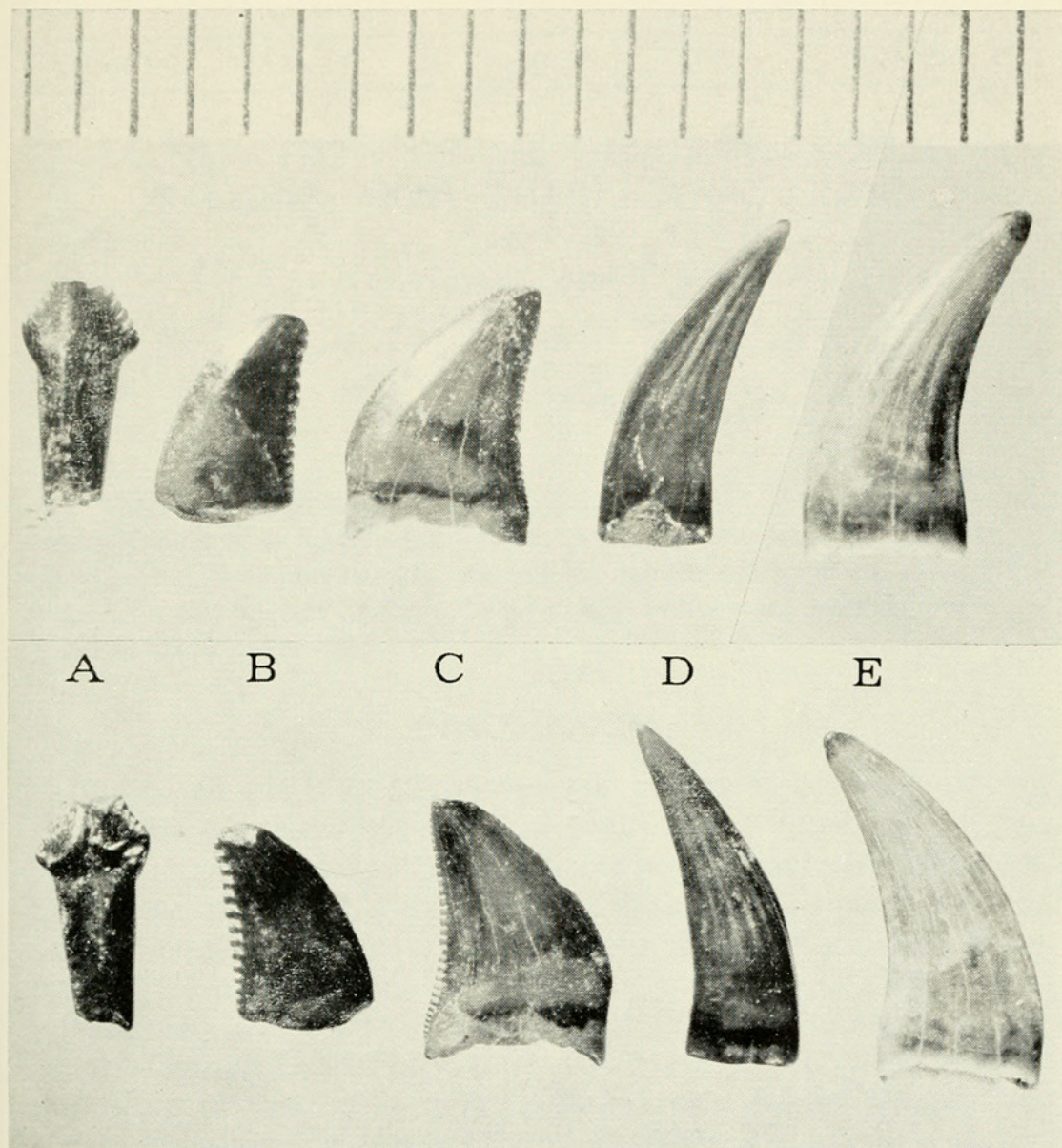


PLATE 1. Dinosaur teeth. A, ?Pachycephalosauridae, MCZ 3729; B, ?Coe-  
luridae, MCZ 3694; C, ?Dromaeosauridae, MCZ 3695; D, *Paronychodon*  
*lacustris*, MCZ 3645; E, cf. *Paronychodon lacustris*, MCZ 3645; Bug Creek  
Anthills, Hell Creek Formation, McCone County, Montana; scale in mm.





Estes, Richard, Berberian, Paul., and Meszoely, C A M. 1969. "Lower vertebrates from the late Cretaceous Hell Creek Formation, McCone County, Montana." *Breviora* 337, 1–33.

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