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**EXTINCT LIZARDS FROM UPPER PLIOCENE
DEPOSITS OF KANSAS**

**EXTINCT TOADS AND SALAMANDERS FROM
MIDDLE PLIOCENE BEDS OF WALLACE
AND SHERMAN COUNTIES, KANSAS**

**By
EDWARD H. TAYLOR**

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EXTINCT LIZARDS FROM UPPER PLIOCENE DEPOSITS OF KANSAS

By EDWARD H. TAYLOR¹

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¹ Professor of Zoology, Department of Zoology, University of Kansas.

ABSTRACT

The state of Kansas is widely known for its fossil-bearing rock strata, which have yielded a great number and variety of extinct vertebrate animals that lived in past ages. For the most part, the vertebrate fossils that are best known belong to the larger forms of mammals, reptiles, and fishes, inasmuch as these are usually the first to be collected. This is probably due to the fact that fossilized bones of the larger animals are more readily discovered and more easily excavated. The faunas of the past, however, did not consist merely of large animals. Just as today we find small species living in the same regions with the larger species, so we may expect the same to be true of past geological periods or epochs.

I have undertaken to find out something about the varieties of these small forms, particularly, the species of lizards, snakes, frogs, toads, and salamanders that lived during late Pliocene time in Kansas; to ascertain their relationships with the present living forms; and to determine whether they throw any light on the climatic conditions that existed in the past, when camels, rhinoceroses, peccaries, three-toed horses, and mastodons were typical large mammals of the state.

This paper treats only of the lizards of the upper Pliocene deposits in Kansas. Four species are here reported for the first time. That this is a significant number is evident when we realize that only three species of lizards have been heretofore known from all of Miocene, Pliocene, and Pleistocene time in North America. One of the three is a horned-toad, one a collared lizard, and these two have been referred to the living genera *Phrynosoma* and *Crotaphytus*, respectively; one, which is from the Miocene, has been made the type of a new genus, having no known living representatives.

In this paper one genus and four species of lizards are described from the upper Pliocene beds of Meade county, Kansas. These are *Eumecoides*, n. gen. (Scincidae?), genotype *E. hibbaridi*, n. sp., *E. mylocoelus*, n. sp., *Eumeces striatulus*, n. sp. (Scincidae), and *Cnemidophorus bilobatus*, n. sp. (Teiidae).

The first two species are small lizards whose relationship is not clear. They are placed in a new genus, and referred, with some doubt, to the family of the skinks. The third species is a skink of the widely distributed genus *Eumeces*, which has living representatives in Africa, Asia, and North America. The fourth species is a whiptail lizard, belonging to a living genus, and to a family which is confined to the western hemisphere.

INTRODUCTION

A small collection of reptilian fossils from the upper Pliocene beds of Meade county, Kansas, was placed in my hands for study by Claude Hibbard, Assistant Curator of Paleontology, in the University of Kansas Museum. The specimens were collected by Hibbard and his party during the summers of 1938 and 1939, and are now a part of the collections of the Kansas University Museum of Vertebrate Paleontology (KUMVP).

The material consists, for the most part, of jaw elements. In no case were any of the separate remains closely associated, so that there is no assurance that any individual is represented by more than a single element. Hibbard regards the beds that yield these fossils as being a flood-plain deposit. The matrix consists chiefly of sandy silts and clays.

Associated with the lizards are jaws and vertebrae of snakes, at least one salamander, several birds, and numerous mammals. A few invertebrate animals, chiefly pulmonate mollusca, are present in the deposit. The contemporary mammalian fauna is being studied by Hibbard, who finds that few of the living genera of mammals are represented.

C. M. Gilmore (1928) has listed a single genus and species of lizard (*Phrynosoma?*) as occurring in Pleistocene deposits of North America, and a single genus and species (*Crotaphytus?*) in the Pliocene. Nothing is listed for the Miocene, but a new saurian genus, *Tetralophosaurus*, has recently been proposed by Olson (1937) based on remains from the lower Harrison beds, of Miocene age, in Nebraska.

The forms identified in recognized living genera offer little data for determining past climatic conditions, inasmuch as both genera are widespread, occupying arid and semiarid, as well as moist and wet regions. Both genera are represented in tropical and temperate regions. Both genera have representatives extending from sea level to 6,000 feet (*Cnemidophorus*) and 12,000 feet (*Eumeces*).

SYSTEMATIC DESCRIPTIONS

Family TEIIDAE Cope 1871

Genus CNEMIDOPHORUS Wagler, 1830 (Whiptail lizards)

CNEMIDOPHORUS BILOBATUS, n. sp.

Figures 1A-C, 2A-C

Type.—KUMVP no. 5084, portion of dentary containing 8 teeth, collected by Claude W. Hibbard and party, 1938.

Occurrence.—Rexroad formation (Smith, 1941, pp. 95-99) upper Pliocene, Loc. 2, about 16 miles southwest of Meade, Meade county, Kansas.

Description of Type.—The outer face of the type specimen shows no part of the coronoid but the scar of attachment is indicated by a slightly depressed area, extending forward to the middle of the fourth tooth (from last). Below the diastema between the eighth and ninth teeth (from last) is a forward-directed foramen, which is situated above the level of the middle of the dentary. The region toward the ventral surface, lying below the fifth to eighth teeth, is smooth, lacking any distinct striation or rugosity. On the inner face of the dentary the Meckelian groove, which is lateral (but becoming ventral anteriorly), and the Meckelian cavity are completely exposed, owing to the absence of the thin splenial, which covers the groove.

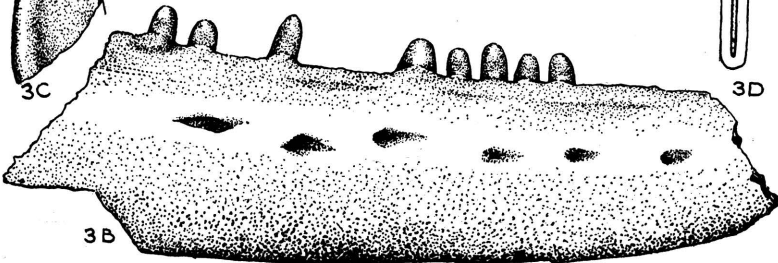
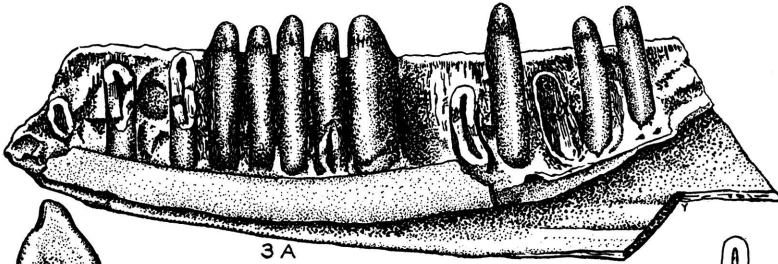
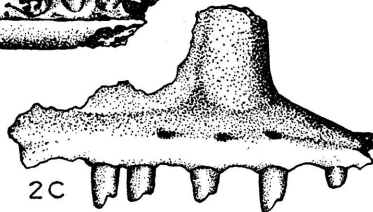
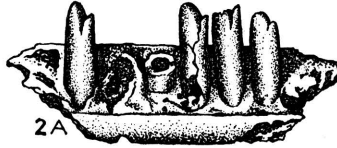
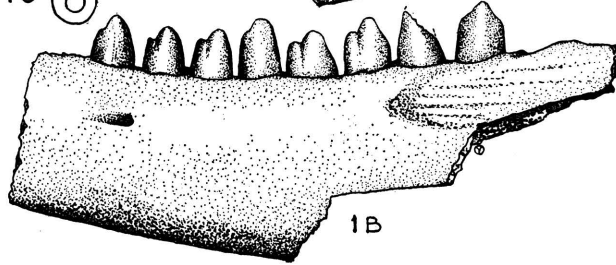
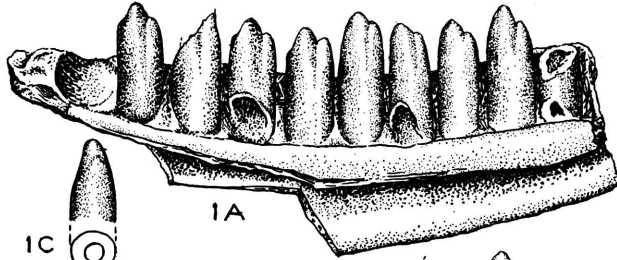
The teeth are pleurodont and unequally bilobed, the small lobe being anterior. The second, fourth, and fifth teeth (from last) show a very faint trace of a still smaller posterior notch or lobe, which is a counterpart of the third lobe, present in certain living species of *Cnemidophorus*. The teeth are wider in proportion to length when compared with modern representatives of *Cnemidophorus* living in this southwestern region, and the crowns seem more blunt, but the latter difference may be due to age and wear. The relative size of the teeth and their characters are shown in figure 1.

The jaw of this extinct species has been compared with the jaws of the living *Cnemidophorus sexlineatus* (Linné), *C. perplexus* Baird and Girard, *C. gularis* Baird and Girard, and *C. melanostethus* Cope. Actually, the only one of these species known in this territory today is *C. sexlineatus*. This form agrees in the normal absence of distinctly trilobed teeth, but differs in having more slender and somewhat more tapering, laterally compressed teeth. The bases are proportionally closer together and the upper parts

FIG. 1. *Cnemidophorus bilobatus*, n. sp. Type (KUMVP no. 5084). A, Median view of the left dentary, enlarged. B, Lateral view of the left dentary. C, Single tooth from near the middle of the series and diagrammatic cross section.

FIG. 2. *Cnemidophorus bilobatus*, n. sp. Referred material. A, Fragment from near the anterior tip of the left dentary (KUMVP no. 5091), enlarged. B, Fragment of the anterior part of right maxilla (KUMVP no. 5081), median view, enlarged. C, Same, lateral view.

FIG. 3. *Eumeces striatulus*, n. sp. Type (KUMVP no. 5079). A, Median view of the right dentary, enlarged. B, Same, lateral view. C, Single tooth from near middle of series. D, Cross section of the same.



are somewhat more widely separated. In *C. gularis*, living in Texas, the four or five posterior teeth are generally trilobed, the posterior lobe being nearly as distinct as the anterior. The posterior teeth of *C. melanostethus* are more like those of *C. sexlineatus*, and the outer posterior face of the dentary is very definitely sculptured and somewhat rugose. *C. perplexus* has teeth that are heavier on the basal portions, and the posterior part of the dentary is smooth. Also, the anterior extension of the coronoid is shorter, reaching forward only to the level of the third tooth, and it is more pointed. The teeth taper more towards their tips and their bases are closer together than in the described new species.

Measurements of the type specimen in millimeters, are as follows: extreme length of fragment figured, 7; elevation of dentary at posterior lateral foramen, 1.8.

Remarks.—The estimated total length of the lower jaw of this species is 25 mm, based on proportional measurements in living species. This jaw size suggests a species somewhat larger than any of the four mentioned forms.

Referred material.—A fragment of a right maxilla (KUMVP no. 5081) from the type locality is referred to this species. The teeth are very considerably smaller than those of the type specimen, which are posterior dentary teeth. However, in nine living species examined, the anterior maxillary and dentary teeth are much smaller than the posterior teeth in the same jaw. In many specimens the tooth at or near the maxillary-premaxillary suture is smaller than the adjacent teeth.

The anterior unbroken profile of the fragment is the posterior outline of the nasal opening. The smallest anterior tooth seemingly is the one that follows the tooth at the suture between the premaxillary and maxillary. The outer face shows three foramina. On the medial face the maxillary shelf is extended above the base of the teeth, and a broken curving edge of a maxillary process is evident.

The teeth are bilobed, hollow, slightly compressed at the tips, but they differ from the living species in that they are almost straight rather than curved medially. The total length of the maxillary fragment is 4 mm, which includes space for 10 teeth; whereas in a space of 4 mm on the posterior dentary series, there are 7 teeth. *C. gularis* has 13 and 7½ teeth in 4 mm in these same

regions. *C. sexlineatus* has 12 and $8\frac{1}{2}$ teeth correspondingly in this distance. The measurements given are based on study of one skull belonging to each species. It is seen that the smaller maxillary teeth might be from an individual as large as the type.

Family SCINCIDAE Gray

Genus EUMECES Wiegmann, 1834 (Skink)

EUMECES STRIATULATUS, n. sp.

Figures 3A-D, 4A,B

Type.—KUMVP no. 5079, major portion of right dentary, bearing eight complete teeth and broken parts of seven more or spaces for them.

Occurrence.—Rexroad formation, upper Pliocene, Loc. 2, about 16 miles southwest of Meade, Meade county, Kansas.

Description of type.—The outer face of the dentary is smooth except for depressions formed by a linear series of six somewhat large foramina, the most posterior one of which is opposite the fifteenth tooth. The outer face of the dentary is strongly curved. The bone is relatively thick, and the lower edge curves slightly.

On the median side, the large Meckelian cavity and groove are evident, the latter being almost wholly ventral. The groove, which is deep posteriorly, becomes shallow anteriorly and terminates near the symphysis. The upper medial edge of the dentary tends to fold up along the base of the teeth, making a slight trough. The lower, outer edge of the dentary is not upturned to present a medial face. The splenial is missing.

The teeth are strongly compressed transversely, each being closely ankylosed to the outer (lateral) dentary wall, so that the connections reach even above the general alveolar edge. The outer face of the tip of the tooth is somewhat rounded and curved medially. The inner, medial face of the tip is slightly concave and striated or puckered, the transverse, cutting edge being blunt.

There are 8 complete teeth in the dentary, the bases of 5 broken teeth, and spaces for 4 more. The posterior part of the dentary, bearing 4, or possibly 5 teeth, is missing. The total number of teeth is about 21, which is about the same as in many living forms. There are 6 or 7 teeth in a space of 4 mm.

Measurements of the type, in millimeters, are as follows; total length of fragment, 9; elevation of dentary at 14th tooth, 2.8; height of same tooth, 2.

Comparisons.—At the present time *Eumeces obsoletus* Baird and Girard, *E. fasciatus* (Linné), *E. septentrionalis* (Baird), and *E. multivirgatus* (Hallowell) occur in territory not far distant from the type locality of the species herein described. The described species is distinctly larger than *E. fasciatus*, *E. septentrionalis* and *E. multivirgatus* and there is no need to compare it with these. A very large specimen of *E. obsoletus* may equal the size of *E. striatulus*.

Compared with a moderately large specimen of *E. obsoletus* the following differences are seen in *E. striatulus*. The teeth are proportionally much wider and somewhat longer. In a space of 4 mm there are 6 or 7 teeth as compared with 9 to 10 teeth in a similar space in *E. obsoletus*. The general character of the teeth is very similar, however. The shape and character of the dentary is similar also, except that the foramina are more numerous (3 only in *E. obsoletus*) and the anterior tip is proportionally higher.

Referred material.—A few fragments are referred to this species. These include no. 5080, which is the tip of a dentary showing parts of 10 teeth or spaces for them. The tip is slightly lower than in the type. No. 5129C is the posterior fragment of a maxilla bearing 2 teeth. No. 5079A is an anterior maxillary fragment bearing several perfect teeth. These are slightly heavier than those in the type dentary and are somewhat longer. This element is, I believe, certainly from an individual other than the type.

Genus *EUMECOIDES*, n. gen. (Skinklike lizard)

Description.—The medial ventral edge of the dentary is turned up, causing the Meckelian groove to be medial rather than ventral. The anterior end of the dentary is narrowed. There are 19 to 22 closely set pleurodont teeth that are strongly ankylosed to the outer wall. The teeth are hollow, having a blunt, chisel-like tip. They are compressed laterally, widening more or less toward the base. Striations are lacking on the medial face of the tips. Referred to Scincidae (with some doubt).

Genotype, *Eumecoides hibbardi*, n. sp.

Two forms, each represented by dentaries, are referred to the genus. They may be differentiated by the following key.

- A. Outer face of dentary concave; terminal part of Meckelian groove shallow; about 18 mandibular teeth. Teeth moderately compressed laterally
E. hibbardi, n. sp.
- B. Outer face of dentary convex; terminal part of Meckelian groove deeper; 21 to 23 mandibular teeth; teeth strongly compressed laterally
E. mylocoelus, n. sp.

EUMECOIDES HIBBARDI, n. sp.

Figures 5A-D

Type.—KUMVP no. 5099, a virtually complete dentary, containing 15 teeth and spaces for 3 more. Collected by Claude W. Hibbard and party, 1936.

Occurrence.—Rexroad formation, upper Pliocene, Loc. 2, about 16 miles southwest of Meade, Meade county, Kansas.

Description of type.—The dentary tapers gradually toward the anterior end, where the width is slightly less than a third of the posterior width. A very slight constriction occurs just back of the first (anterior) tooth. The outer face of the dentary shows a shallow, but distinct, longitudinal concavity. There are 7 foramina, which are not arranged regularly but in a more or less linear series on the anterior part, the posterior foramen being opposite the base of the 10th tooth. The posteroventral surface of the dentary is more than one-half of the width of the outer face, narrowing anteriorly. The medial edge of the ventral part of the dentary is turned up, causing the Meckelian groove to open medially rather than ventrally. The greatest width of the upturned edge is anterior to the middle. The groove is almost obsolete at the top. The medial face of the dentary is turned up, so as to conceal the bases of the teeth, in lateral view, its widest part being at about the middle. No trace of a scar or suture of the coronoid is seen, and the splenial suture hardly is evident.

The teeth are of the pleurodont type, those near the median part of the series being longest and most robust. There are about 18 hollow teeth (3 or possibly 4 missing), their tips being somewhat compressed longitudinally, so as to be bluntly chisel-like, and each tooth as a whole is more or less compressed transversely to the long axis of body (fig. 5C). Anchylosis of the tooth and bone takes

place below the alveolar border, instead of reaching to and above the alveolar level as in *Eumeces striatulus*. The narrowest diameter of the teeth is much less than one-half of the greatest diameter.

The species is named for Claude W. Hibbard, Curator of Lower Vertebrates, Dyche Museum of Natural History, University of Kansas.

Measurements of the type specimen, in millimeters, are as follows: greatest length of dentary, virtually complete, 8.2; greatest vertical width, 2.65; narrowest point, posterior to first tooth, .75, greatest ventral width, 1.5; height of longest tooth, 1.15.

Remarks.—The reference of this genus to the Scincidae is based on general resemblances more than on specific characters. The relationship to *Eumecoides mylocoelus*, n. sp., is shown in the key.

EUMECOIDES MYLOCOELUS, n. sp.

Figures 6A-D

Type.—KUMVP no. 5115, a dentary slightly broken posteriorly, bearing spaces for about 23 teeth (15 teeth present). Collected by Claude W. Hibbard and party, 1936.

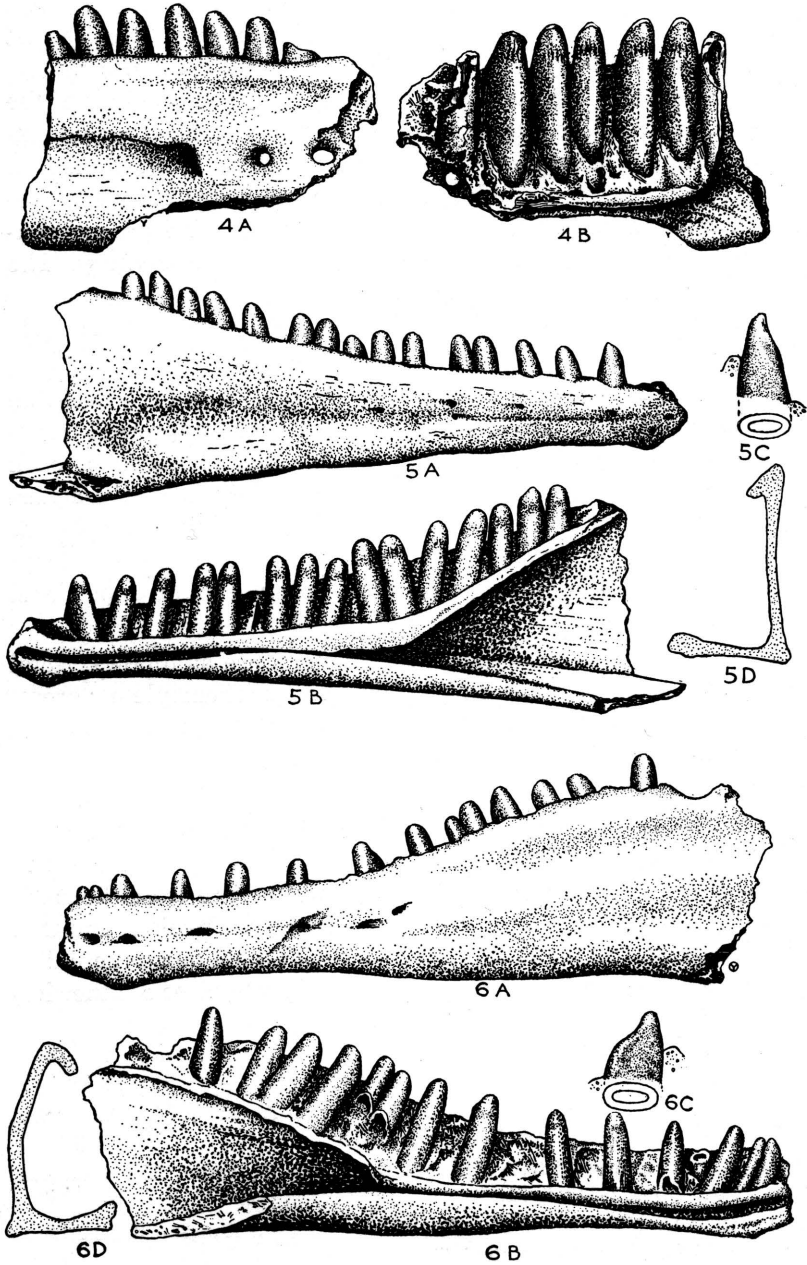
Occurrence.—Rexroad formation, upper Pliocene, Loc. 2, about 16 miles southwest of Meade, Meade county, Kansas.

Description of type.—The outer face of the dentary is generally convex, but two slight, longitudinal depressions are evident on the posterior part. A longitudinal series of 5 somewhat large foramina occupies the anterior part of the outer face, nearly midway between the upper and lower edges. The most posterior of the series is about opposite the base of the 11th tooth. The lower profile of the dentary is somewhat sinuous, a prominent elevation on the anterior ventral border being opposite the third tooth. The element

FIG. 4. *Eumeces striatulus*, n. sp. Referred material. A, Fragment of right dentary from near middle of bone, lateral view, enlarged. B, Same, median view.

FIG. 5. *Eumecoides hibbardi*, n. gen., n. sp. Type (KUMVP no. 5099). A, Lateral view of right dentary, enlarged. B, Same, medial view. C, Tooth from middle of series. D, Cross section of posterior part of dentary.

FIG. 6. *Eumecoides mylocoelus*, n. gen., n. sp. Type (KUMVP no 5115). A, Lateral view of left dentary, enlarged. B, Same, medial view. C, Single tooth from near middle of series. D, Cross section of dentary (reconstructed to show contrast with fig. 5D).



is widest posteriorly, narrowing to a point between the fifth and seventh teeth, where the greatest constriction occurs. The greatest width of the dentary is about 2.5 times the narrowest width. The greatest width of the ventral surface is more than one-half of the greatest width of the lateral surface. No trace of the coronoid suture is seen. The medial ventral edge, distinctly thickened, is turned up on the medial side, causing the Meckelian groove to present a median rather than a ventral opening. The groove continues to be well defined to the anterior tip of the dentary. The median face of the dentary above the groove is hardly upturned, at least on the anterior half (broken posteriorly), so that in lateral view the tooth bases are not concealed by an upturned edge.

Tips of the teeth are compressed, forming a blunt chisel-like edge longitudinally, but the teeth are strongly compressed transversely to the longitudinal axis, the greatest diameter of each tooth being twice its narrowest diameter. The teeth have a narrow, oval pulp cavity. Teeth of the medial part of series are longer and most are wider transversely than the other teeth. The ankylosis of the tooth and bone does not extend quite to the upper level of the dentary bone.

Measurements of the type, in millimeters, are as follows: total length of dentary, 8.6 (possibly slightly longer if complete); greatest vertical width, 2.45 (possibly 4.6 if complete); narrowest width between fifth and seventh teeth, .95; greatest ventral width, 1.3; height of longest tooth, 1.2.

Remarks.—The chief difference between the teeth of the two forms referred to this genus is the greater width of the teeth in *Eumecoides mylocoelus*. The teeth illustrated are from the same place in the jaws, that of *E. mylocoelus* being the twelfth, and that of *E. hibbardi*, the tenth tooth. However, I do not deem these differences greater than differences that obtain in species of other living genera of saurians.

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For glossary see Part 6, pp. 195-196.

EXTINCT TOADS AND SALAMANDERS FROM
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By EDWARD H. TAYLOR¹

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¹ Professor of Zoology, Department of Zoology, University of Kansas.

ABSTRACT

Fossil remains of frogs and toads of the western hemisphere have been studied little, and only 7 species of extinct frogs and toads have been described from this enormous area. At least 4 frogs and toads and 1 salamander are from western Kansas. The salamanders are scarcely better known. Thus it is important to record here the presence of other salamanders, and give added information on the frogs and toads of the region, in the hope that when the entire Pliocene fauna is known, it may throw some light on the character of the climates of late Tertiary time and give some clues to the ancestry of the living amphibians of Kansas.

In this paper the following forms are described from middle Pliocene beds of extreme western Kansas: *Lanebatrachus*, n. gen., genotype, *L. martini*, n. sp. (Caudata, Ambystomidae?), *Ogallalabatrachus*, n. gen., genotype, *O. horarium*, n. sp., (Caudata, Ambystomidae), *Scaphiopus antiquus*, n. sp., *S. pliobatrachus* Taylor (Anura, Pelobatidae), *Bufo hibbardi* Taylor, *B. arenarius* Taylor (Anura, Pelobatidae). The splenial of *Plioambystoma kansense* Adams also is described.

One of the surprising facts concerning this fauna is the abundance of toads and the seeming absence of the ordinary frogs of the genus *Rana*, which today are usually the most conspicuous members of any amphibian fauna in the United States.

This is not true of the amphibian fauna of the upper Pliocene deposits of Meade county, Kansas, or the Broadwater beds of Nebraska, because in both places frogs of the genus *Rana* predominate, and toads are rare or absent.

INTRODUCTION

The first amphibian described from the Edson beds, Ogallala formation, middle Pliocene, Sherman county, Kansas, (Adams and Martin, 1921; Elias, 1931, p. 161) was a salamander, *Plioambystoma kansense* Adams (Adams and Martin, 1921). This form is extremely common in these beds and several thousand separate fossil bones in nearly perfect condition have been recovered from the sand matrix. In fact, all the bony elements of the typical ambystomid salamanders have been found, except the prevomers.

Associated with this material were several fossil bones belonging to anuran amphibians. I undertook a study of these and the results were presented at the Seventh Pan-American Congress in México (City), México, in 1935 (Taylor, 1936). In this paper appeared the original descriptions of *Scaphiopus pliobatrachus* Taylor, *Bufo hibbardi* Taylor, and *B. arenarius* Taylor, which are re-described here. Later (Taylor, 1939) I described a new pelobatid

toad from a diatomaceous marl, which lies in contact with the "Edson beds" (Elias, 1931, p. 161). This was named *Scaphiopus studei* Taylor.

For several years I have had at hand fragmentary fossil remains of certain other amphibians from these beds. In 1935, accompanied by David Dunkle, I visited the locality hoping to obtain additional material referable to these forms. We were unsuccessful in this; but specimens referable to two other species were obtained.

SYSTEMATIC DESCRIPTIONS

Order CAUDATA

Family AMBYSTOMIDAE Cope

Genus PLIOAMBYSTOMA Adams, 1921

PLIOAMBYSTOMA KANSENSE Adams

In a reexamination of the material on which Adams based this species, I have noted an element that he does not mention. Eight of the lower jaws show fragments of the splenial. Inasmuch as these fragments seem to be attached to different points on the dentary, one can reconstruct the general shape and extent of the splenial bone. It is probable that these jaws belonged to neotenic or larval specimens.

The splenial is attached at a point about 1.5 mm from the symphysis on the inner side of the dentary and it extends posteriorly to a point below the last tooth of the dentary. It is somewhat curved and bears teeth, which extend the length of the element. Near the anterior point of attachment, the tooth-bearing ridge is separated from the dentary teeth by 0.6 mm. Posteriorly the splenial and dentary series are directly together. The splenial lies above the Meckelian groove and only partly covers it. This element is probably cartilaginous. In a fossilized state it is creamy white in color in sharp contrast to the darkened dentary.

The absence of prevomers and vomerine teeth in the great lot of material suggests that these elements were cartilage, and that vomerine teeth were poorly developed. It is of course not impossible that they were wholly absent from the skull.

Genus *LANEBATRACHUS*, n. gen.

A genus characterized by a dentary that is flattened posteriorly and bent out at an angle, and provided with a slight "coronoid" process.

This genus is named in honor of H. H. Lane, Professor of Zoology and Director of Dyche Natural History Museum, University of Kansas.

Genotype.—*Lanebatrachus martini*, n. sp. (ambystomid salamander).

Horizon.—"Edson beds", Ogallala formation, middle Pliocene, Sherman county, Kansas.

LANEBATRACHUS MARTINI, n. sp.

Figures 4A,B

Type.—KUMVP no. 1468, portion of dentary and angulare, collected by H. T. Martin.

Occurrence.—"Edson beds", Ogallala formation, middle Pliocene, Sherman county, Kansas.

Description.—Among the material found associated with *Plioambystoma kansense* is a lower jaw belonging to an undescribed genus of caudate amphibians. The jaw consists of the major portion of the dentary attached to the posterior part of the angulare. There is evidence of 40 teeth along the remaining edge, 9 mm long, making a probable total number of more than 50 teeth for the complete jaw. Posteriorly the element is flattened and bent out at an angle. The greatest (vertical) width is at the point directly behind the last tooth, where there is a slight "coronoid" process. Behind this point the element narrows rapidly. The posterior tip is missing. At a point near the middle, where the jaw begins to curve inward, there is an inflation or bulge on the outer face. At no point is the jaw much thickened. Where it seems to be thicker, one notes that on the inner face the Meckelian groove is deeper. There is no trace of a splenial.

The angulare shows considerable normal torsion. The anterior higher part is turned strongly inward, and when viewed from above, it displays much more surface than this same element in *Plioambystoma kansense*. There is a distinct vertical groove on the thickened lower outer edge. There is no trace of the articulare.

The shape of the angulare and the dentary suggests a wide, short head, which is smaller than that of *Plioambystoma kansense*. The lower jaw is more delicate and more slender, and the lower edge not thickened. The dentary of *Plioambystoma* forms a more or less continuous curve, whereas that of *Lanebatrachus* has the anterior part curved inward and the posterior part bent outward, so that the main axis forms a sigmoid curve.

The species is dedicated to the late Handel T. Martin, former Assistant Curator of the Kansas University Museum of Vertebrate Paleontology, who discovered the type specimen.

Genus OGALLALABATRACHUS, n. gen.

A genus characterized by short vertebrae in which the centra are strongly constricted medially, and much expanded at each end.

Genotype.—*Ogallalabatrachus horarium*, n. sp.

Occurrence.—Ogallala formation, middle Pliocene, Rhinoceros Hill, Wallace county, Kansas.

OGALLALABATRACHUS HORARIUM, n. sp.

Figures 7A-C

Type.—KUMVP no. 1470, a dorsal vertebra, collected by E. H. Taylor and David Dunkle.

Occurrence.—Ogallala formation, middle Pliocene, Rhinoceros Hill, Wallace county, Kansas.

Description.—Associated with the vertebrae of *Plioambystoma kansense*, found at the above locality, is a single, large vertebra that belongs seemingly to a different genus. It probably is likewise referable to the Family Ambystomidae.

The centrum of the vertebrae is very short, but the diameter is relatively large. Posterior to the diapophyses, the centrum is greatly constricted, 1.2 mm in diameter, whereas at the anterior end it measures 4 mm, and at the posterior end 3 mm. The diapophyses and parapophyses for rib articulation arise near the middle of the bone, and are directed outward and backwards. The two are joined together almost to their distal points by a weblike bony connection, the combined width at the tip being 2.8 mm.

The length of the centrum is 5 mm. The notochordal perforation is about 0.5 mm in diameter. Within the notocoele there is a distinct offset as if a second tube were inserted in the middle of the centrum, the edges forming the offset. The prezygapophyses have large articular surfaces. The terminal neuropophysis is large and broad, bearing a small spearlike elevation that is flattened against the ventral surface and pointed backward. Two small openings occur in the tip of the neuropophysis. The elevation of the vertebra is 7 mm above the base of the centrum. The dorsal surface of the arch has a very slight keel.

Referred material.—A single element, a sacral rib, is referred to this species. It is distinctly larger than the sacral rib of *Plioambystoma kansense* and bears a sharp spine, the tip of which is now broken. Its greatest length is 7 mm; greatest width, 3.3 mm; distance from head to base of spine, 3.2 mm.

The type specimen shows distinct torsion, and is not very symmetrical. Compared with the vertebrae of *Plioambystoma* the diameter of the centrum is much larger, the cup more shallow, and the centrum shorter. The notochordal canal pierces the centrum in *Ogallalabatrachus horarium*, which is not true of *Plioambystoma kansense*. I presume that this new species is a much larger form than the *Plioambystoma*.

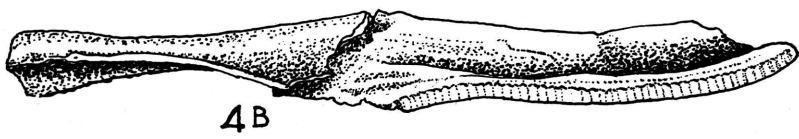
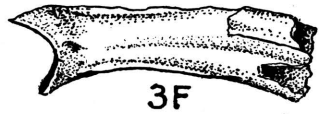
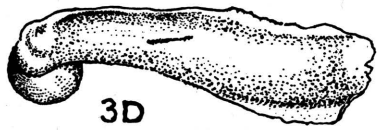
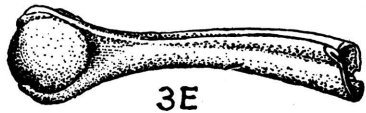
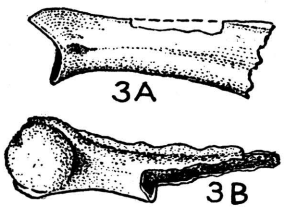
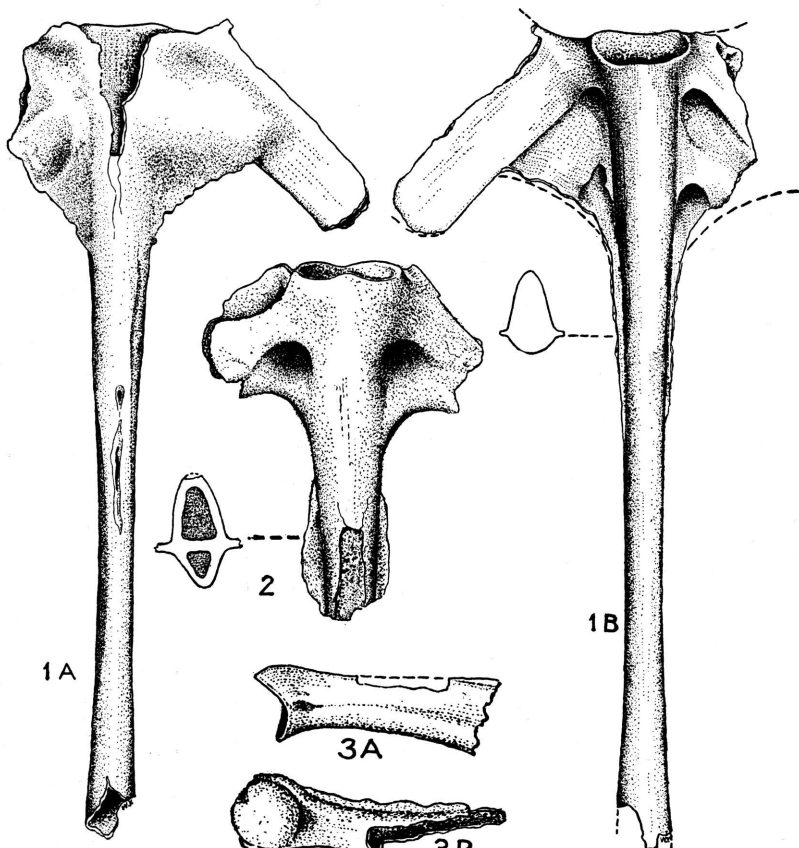
The Rhinoceros Hill deposit, as interpreted by Elias (1931, p. 161) lies 50 to 80 feet higher than the "Edson beds", at the type locality of *Plioambystoma*. A few vertebrae, which have been temporarily referred to *P. kansense*, were also found in the Rhinoceros Hill deposit.

FIG. 1. *Scaphiopus pliobatrachus* Taylor. Type (KUMVP no. 1430). Coccyx and sacral vertebra fused (actual length, 18 mm). A, Ventral view. B, Dorsal view, showing cross section.

FIG. 2. *Scaphiopus antiquus*, n. sp. Type (KUMVP no. 1469). Sacral vertebra and coccyx fused (actual length, 7 mm).

FIG. 3. *Scaphiopus pliobatrachus* Taylor. A, Radio-ulna (KUMVP no. 1434). B, Humerus (KUMVP no. 1432). C, Ilium (KUMVP no. 1436). D, Lateral view of humerus (KUMVP no. 1431). E, Same. F, Radio-ulna (KUMVP no. 1433).

FIG. 4. *Lanebatrachus martini*, n. gen., n. sp. Type (KUMVP no. 1468). A, Dentary and angulare. B, Same, showing median surface (enlarged).



Order ANURA

Family PELOBATIDAE Boulenger, 1882

Genus SCAPHIOPUS Holbrook, 1836

SCAPHIOPUS ANTIQUUS, n. sp.

Figure 2

Type.—KUMVP no. 1469, portion of combined sacral vertebra and coccyx, collected by David Dunkle and E. H. Taylor.

Occurrence.—"Edson beds", Ogallala formation, middle Pliocene, Sherman county, Kansas.

Description of the type.—The shaft, including bases of the sacral diapophyses, measures 5.4 mm, the total length of the fragment being 7 mm; width of the base of the sacral diapophysis, 1.3 mm; greatest diameter of the articular fossae, 1.7 mm; diameter of shaft between openings of last pair of neural foramina, 1.7 mm; greatest depth of the shaft, 2.15 mm. The seeming asymmetry of the expanded postsacral portion is due doubtless to wearing. The edges are smooth, however, as if this were the original condition. The lateral crests, now discontinuous with the expanded postsacral portion, may have been originally continuous.

Compared directly with *Scaphiopus pliobatrachus* there is a difference in the shape and character of the origin of the sacral diapophyses with regard to the articular fossae, and the processes of the postsacral vertebra are not in evidence. The openings for the nerves are very different and the bony web between the process and the shaft seems to be less extensive. This is shown by comparison of the measurements and drawing of the cross-section of the shaft.

The proximal width of the sacral processes in the new species described is much less than in *Scaphiopus studeri* Taylor, and there is distinctly more of a bony web between the transverse process and the shaft.

SCAPHIOPUS PLIOBATRACHUS Taylor

Figures 1A,B, 3A-F

Scaphiopus pliobatrachus TAYLOR, 1936, Anal. Inst. Biol. (Mexico), vol. 7, no. 4, pp. 515-521, pl. 1, fig. 1. "Edson beds", Ogallala formation, middle Pliocene, Sherman county, Kansas.

The type specimen (KUMVP no. 1430) of this species consists

of a sacral vertebra joined with the coccyx. Typical of the known members of the family Pelobatidae, the coccyx is solidly fused with the sacrum. The available material shows such similarities to the modern genus *Scaphiopus* that I have deemed it unnecessary to erect a new genus. When complete details of the skull are known this may be necessary, however.

Description of the type.—Posterior to the widened sacral vertebrae, there seems to be evidence of a postsacral vertebra that is fused to the coccyx, as is typical in the genus *Scaphiopus*. No processes on the sacral element such as occur in certain living forms are seen, but the worn nature of the edges make it not certain whether they were originally absent. The coccyx is distinctly compressed and it lacks evidence of both dorsal and ventral crests. Lateral crests arise near the middle, and they widen forward, joining the expanded postsacral region, which is continuous with the proximal part of the expanded sacral diapophyses. The base of the crest is widened at the point of contact with the coccygial shaft.

The sacral vertebrae are procoelous, articulating with a single condyle. The portion of the diapophysis that is present suggests a flattened process as wide distally as its length from the centrum. The width of the diapophysis where it joins the centrum is 1.4 mm.

The neural canal is much narrowed dorsoventrally and a large antero-dorsal notch is present in the arch. The concave articular fossa is shallow, the ventral floor extending farther forward than the dorsal.

Measurements of the type in millimeters are as follows: total length of combined elements, 18; greatest depth of coccyx, at junction with sacrum, 2; width of shaft at foramina of last nerve, 2; estimated width of sacral vertebra with diapophyses, 12; width of base of the sacral diapophysis, 1.4; width of centrum between nerve foramina, 1.9.

Referred material.—I am associating with this type certain other bones that seem to belong to this species—some not improbably to the same specimen, inasmuch as the proportions are such as one would postulate on the basis of measurements of modern species.

Humerus (KUMVP no. 1431). This element, which is nearly complete, shows a distinct similarity to the strongly com-

pressed humerus of living species of *Scaphiopus*. The distal median condyle is globular. A strong preaxial crest (deltoid ridge) that begins near the head continues to the lateral edge of the median condyle. A well-defined postaxial crest runs nearly the length of the bone, this being absent in living forms examined. A short, low, ridge arises near the condyle below the preaxial crest. The entire element is strongly compressed. The minimum width is 1.4 mm; greatest width, 5 mm; greatest width at condyle, 3.2 mm; estimated length, 15 mm.

A second humerus (KUMVP no. 1432), a distal fragment, agrees with the previous element in many characters but is obviously from a different individual. It is somewhat smaller but the crests are precisely as in the first specimen. It has the same condylar width and its estimated length is 14.2 mm.

R a d i o - u l n a . Two specimens of the radio-ulna (KUMVP nos. 1433, 1434) are referred to *Scaphiopus pliobatrachus*. The distal ends of each bone have lost the epiphyses. The postaxial (ulnar) part of each forms a moderate olecranon, and from this arises a post-axial crest that probably extends the entire length of the bones. The crest is not truly vertical from the shaft but tends to turn or curve slightly. The grooves between the ulnar and radial parts are strongly evident on both sides. Two small pitlike depressions occur near the fossa. A small lateral ridge is present on the preaxial side near the proximal end.

Specimen no. 1433 may belong to the same individual as humerus no. 1431 for they fit together perfectly. Likewise, specimen no. 1434 fits perfectly with humerus no. 1432. The estimated total length of no. 1433 is 12 mm; that of no. 1434, 11.2 mm.

S c a p u l a . A single scapular element (KUMVP no. 1435) is referred to this species. The glenoid articular surface is narrow, elongate, curved on its inner and outer edges as is true of present day *Scaphiopus*. The condyle articulating with the clavicle is broken. On the dorsal edge of the head is a strong crest, rising from a point near the outer edge of the clavicular condyle. It is not vertical but slightly inclined, forming a somewhat convex surface on one side and a slightly concave surface on the other. There are no tubercles, and no subscapular depression near the dorsal proximal end is evident.

I l i u m . A fragment (KUMVP no. 1436) consisting of a slightly curved shaft of an ilium broken off at the edge of the acetabulum is

referred to this species. There is a trace of a groove along the inner (medial) surface. The average width is 1.3 mm. The length of the fragment is 13 mm.

Compared with *Scaphiopus studei* Taylor there is a marked difference in the character of the lateral crests on the shaft of the coccyx and in the degree of distinctness of the postsacral vertebra, as well as in the union of the dilated diapophyses with the centrum. The humerus of *S. studei* is longer and less widened in proportion. The two humeri measure 16 mm long by 4.6 mm wide, and 15.8 mm long by 4.8 mm wide (about 15 mm long to 5 mm wide in *S. plio-batrachus*); diameter of the condyle 2.3 mm (3.2 mm in *S. plio-batrachus*). The deltoid or postaxial crest does not extend to the distal condyle, and the other crests are not discernible.

Family BUFONIDAE Hogg, 1841

Genus BUFO Laurenti, 1768

BUFO HIBBARDI Taylor

FIGURE 5

Bufo hibbardi TAYLOR, 1936, Anal. Inst. Biol. (Mexico), vol. 7, no. 4, pp. 517-521, pls. 1, 2. "Edson beds", Ogallala formation, middle Pliocene, Sherman county, Kansas.

Description of type.—The specimen is complete except for the ends of the diapophyses. On the dorsal surface of the neural arch is an elevated crest forming a median right angle, from the apex of which a slight crest runs forward and downward to the anterior, interior edge of the arch. The prezygapophyses are ample, rounded, projecting, and there is a slightly hollowed area posterior to their bases. The dorsal surfaces of the diapophyses are somewhat ridged or rugose. A slight irregular ridge parallels the anterior edge of the diapophysis, behind which is a very shallow, slightly depressed area. Along the upper part of the posterior face of the diapophysis is a slight ridge, which seems to be a lateral extension of the triangular dorsal crest. The ventral surfaces of the diapophyses are smooth. The centrum bears a pair of comparatively large salient condyles, which are very closely approximated. On the ventral surface of the procoelous centrum is a longitudinal groove that becomes almost obsolete posteriorly.

The measurements of the type in millimeters are as follows: greatest transverse width (estimated), 21; actual length of longest

half, 10; width of diapophyses at base, 3; estimated distal width, 8; length of centrum, 4.4; width of the two sacral condyles, 5; width of body of centrum, 4; width of arch (measured longitudinal to body; 1.9; depth of centrum, 3; height of canal, 0.9.

Referred material.—Scapula (KUMVP no. 1438). This specimen is in excellent condition. The bone is slightly bowed in typical fashion. The glenoid articular surface is broad and rounded. The surface articulating with the clavicle is widened in part proximal to the fossa. On the outer face of the clavicular head of the scapula is a broad, shallow groove. Rising from the outer edge of the clavicular (acromial) head is a low, somewhat thick crest extending about a third of the length of the bone, a slight shallow groove marking its base. Below the glenoid process is a tubercle-like crest. The subscapular fossa is scarcely discernible.

Greatest length, 14.2 mm; width at neck, 3.4 mm; width at superior end, 6 mm; height from notch to end of acromial process, 4.3 mm.

Humerus. (KUMVP no. 1439). A part of the proximal end of this element, articulating with the glenoid, is missing but the distal portion is complete. The condyle is rounded, large, and the two lateral articular surfaces pronounced, each provided with a slight ridge. The distal dorsal surface of the shaft is flattened.

Width of condylar end, 6 mm; length of fragment, 17 mm; estimated total length, 32 mm.

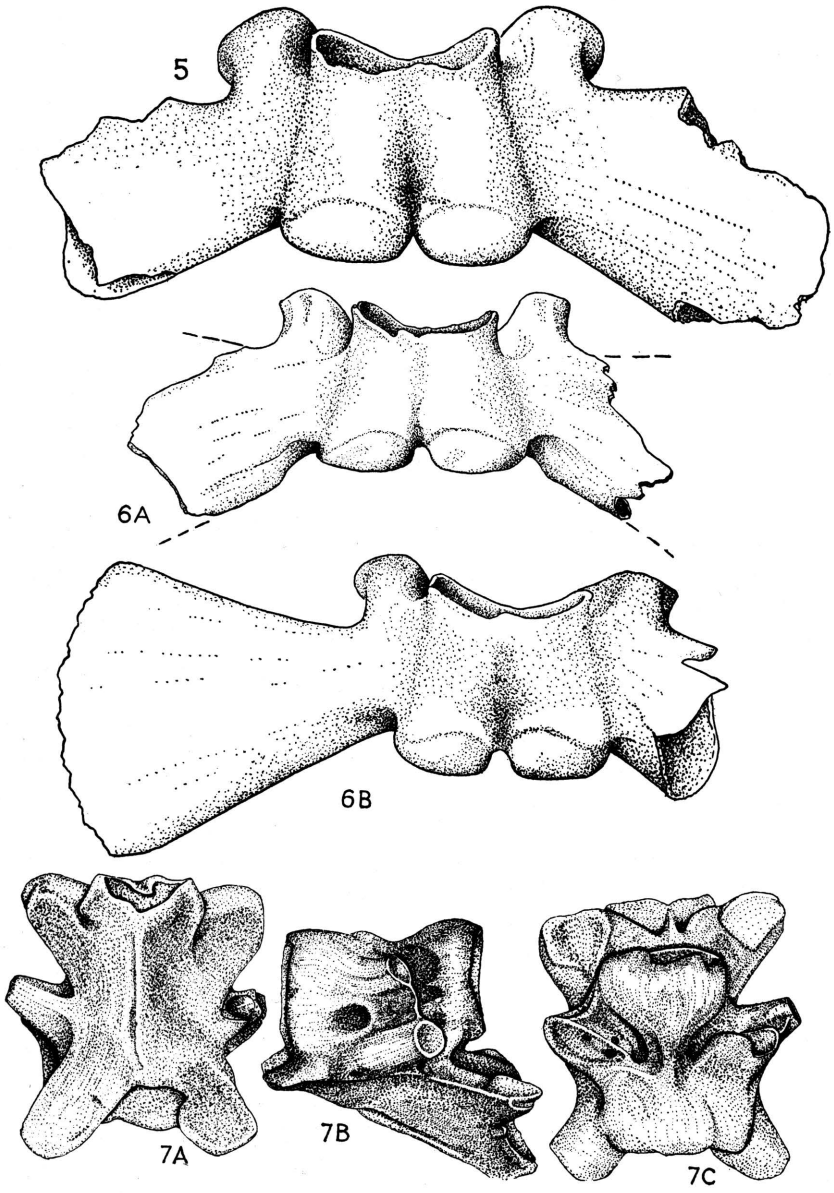
Radio-ulna. (KUMVP no. 1440). The distal articular ends of this element are missing. The fossa fits perfectly with the condyle of no. 1439. The olecranon is high and thick, the angle formed by the fossorial notch a right angle; there is a strongly defined, angular pit on the proximal anterior face. The groove between the ulnar and radial parts is evident only distally, where it is pronounced above and below. The bone is somewhat strongly compressed except at the fossorial head.

Length of fragment, 15 mm; estimated total length, 20 mm.

FIG. 5. *Bufo hibbardi* Taylor. (KUMVP no. 1472). Sacral vertebra.

FIG. 6. *Bufo arenarius* Taylor. A, (KUMVP no. 1470), sacral vertebra. B, (KUMVP no. 1474), sacral vertebra.

FIG. 7. *Ogallalabatrachus horarium*, n. gen., n. sp. Type (KUMVP no. 1470), vertebra. A, Dorsal view. B, Same, lateral view. C, Same, ventral view. (All enlarged).



S k u l l. (KUMVP nos. 1441, 1442). Fragments of the posterior portion of the skull of two individuals seem to belong to the same species in spite of some variations, but they certainly are from different individuals, inasmuch as both are from the right side. The condyles and proötic regions are typical of the genus. The foramen ovale is open, the columella lacking. The knoblike projection on the medial edge of the proötic, (typical of the Bufonidae), varies slightly in character in the two specimens.

Nos. 1443, 1444, and 1445 are fragments of the frontoparietal, from which very heavy, thick crests arise. These are especially heavy at the juncture of the supraorbital and the postocular crests.

U r o s t y l e. (KUMVP no. 1446). A single large fragmentary bone is associated with this form, the dorsal anterior part, including the articular fossa, being missing. The dorsal crest rises gradually for a few millimeters, then bifurcates, forming two ridges separated narrowly along the top of the crest. How far forward this continues cannot be discerned. Anteriorly, the shaft of the urostyle becomes slightly curved in the vertical plane and flattened horizontally, forming flat shelves on each side of the crest, the edges of which project slightly. This free edge terminates forward somewhat behind a pronounced tubercle. The ventral side of the bone is finely striated.

The length of the fragment is 23 mm; the estimated total length is 27 mm.

F e m u r. (KUMVP no. 1447). A fragment of a femur is assigned to this form. The bone is slightly sigmoid. The acetabular head is missing. A very much compressed crest arises near the middle and continues forward. At its highest elevation it presents a very sharp edge, then descends and spreads to form a flattened facet for muscle attachment. The epiphysis on the distal end is missing but the head is complete. In cross section it is much broader than deep. The shaft of the bone near the middle is nearly cylindrical but shows a very slightly angular elevation on one side.

The length of the fragment is 25 mm; the estimated total length is 31 mm.

T i b i a - f i b u l a. (KUMVP no. 1449). The shaft of this double element is nearly complete except for the epiphyses. The foramina on the shaft open on opposite sides, one about 2 mm in advance of the other.

The length of the fragment is 30 mm; the estimated total length is 33 mm.

Ilium. (KUMVP no. 1449). A single complete ilium and two acetabular fragments are referred to this form (KUMVP nos. 1450, 1451). The shaft is strongly curved, a partly broken, but well-defined dorsal prominence occurring above the acetabulum. A slight medianly directed crest is present on the dorsal surface near the middle of the shaft. A distinct longitudinal groove is present on the outer face. Below the acetabulum the bone is very thin and flares out somewhat. The two fragments of the acetabular portion do not differ appreciably.

The width of the basal portion is 10 mm; the length of the bone is 32 mm; the greatest diameter of the acetabular fossa is 5 mm.

Sacral vertebra. (KUMVP no. 1472). A second specimen of a sacral vertebra has been obtained from the same locality as the type since the first description was published. It agrees with the type in essential details. A figure is given of this specimen (fig. 5).

The measurements in millimeters are as follows: actual length of element (termination of the diapophyses broken), 18; length of centrum, 4.5; combined width of condyles, 5.2; width of diapophyses at base, 2.9; width of body of centrum, 4.1; width of arch, measured longitudinally to body axis, 2; depth of centrum, 3.1; height of canal, 1; posterior width of canal, 3.1.

BUFO ARENARIUS Taylor

FIGURE 6A, B

Bufo arenarius TAYLOR, 1936, Anal. Inst. Biol. (Mexico), vol. 7, no. 4, pp. 521-525. "Edson beds", Ogallala formation, middle Pliocene, Sherman county, Kansas.

The type of this species is a sacral vertebra (KUMVP no. 1452) collected by H. T. Martin and Claude Hibbard.

The sacral vertebra is somewhat fragmentary, lacking the greater portion of the right transverse process, and the anterior edge of the left is likewise broken. The condyles are complete and in dorsal view are only slightly visible, being concealed by the arch. They are separated from each other at their bases by a distance of about 0.4 mm. The total width across the two condyles is

3.6 mm. Each condyle is wider transversely than vertically. On the ventral surface of the centrum, anterior to the condyles, are two slightly raised, transverse areas. The groove between the condyles continues forward, but is very shallow. The vertebra is procoelous, the cavity being deep, distinctly wider transversely than vertically (2.6 mm and 1.8 mm).

The neural canal is much wider than deep (2 mm; 0.7 mm). The neural arch is flattened, and has a slight V-shaped crest, which is flattened on the dorsal surface. On the posterior side of the arch are two indistinct, transverse concavities or grooves. The transverse process is widened; its actual width cannot be ascertained, but, judging by extending the lines on the side of the base, it seems to be slightly more than a fourth less than the length from the point of attachment to the centrum. The posterior edge of the basal portion has a slight, irregularly roughened crest, thickened proximally and terminating in a narrow point. The prezygapophyses are represented by the broken base of the left one only.

The measurements of the type in millimeters are as follows: length of the centrum, 2.8; width of centrum anteriorly, 2.6; greatest height of vertebra, 3.1; width of constricted base of transverse process, 2.1; estimated length of transverse process to middle of centrum, 10; estimated distal width of transverse process, 5.

Referred material.—*V e r t e b r a*. (KUMVP nos. 1453, 1454). These two vertebrae are very probably a part of the type specimen and represent the second and fourth. One is virtually complete, the other fragmentary; the processes are missing. The pre- and postzygapophyses are of proper size for articulation together. The centra are very short (exclusive of the condyle they are slightly more than 2 mm in length); the arch is high; the cavity of the second vertebra has a vertical diameter of 2.5 mm.

H u m e r u s. (KUMVP nos. 1455, 1456). These are the distal ends of the humeri having a rounded condyle, flanked by two typical articular surfaces. The total width of the distal head is 5 mm.

R a d i o - u l n a. (KUMVP no. 1457). This element, complete except for a fragment missing from the side of the ulnar shaft, has a somewhat narrow olecranon. In lateral profile the angle of the olecranon with the head of the radius is a right angle. It fits perfectly with the condyle of no. 1455. The crest on the postaxial edge

is almost completely obsolete. The groove separating the two elements is distinct. Its total length is 12 mm.

Scapula. (KUMVP no. 1458). This element is complete and typical of *Bufo*. The end articulating with the suprascapula is moderately widened and on the ventral surface there is a somewhat broadened, shallow concavity. The acromial head is considerably longer than the glenoid process, and bears a low crest, which continues to the constricted portion of the bone. Below the glenoid process there is an elongate tubercle or crest, deflected laterally, reaching the base of the process.

Femur. Three femora (KUMVP nos. 1459, 1460, 1461) are referred to this form, the first complete except for the epiphyses. The bone is somewhat sigmoid. Posterior to the acetabular head, a low keel arises, which bears an elongate facet for muscle attachment on the anterior part. Both heads are distinctly longer than wide. No. 1460 has the constricted portion of the bone slightly narrower, and the distal head slightly larger than the preceding. The acetabular head is wanting. In no. 1461 the acetabular head and part of the epiphysis are present, as well as the anterior part of the shaft and the keel. The last two elements seem to belong to the same individual. Nos. 1462 and 1463 represent the distal halves of humeri having the epiphyses intact.

The measurements of no. 1459 in millimeters are as follows: length, 25; estimated length with epiphyses, 28; width of constricted portion, 1.4; width of shaft and crest, 3; width of distal head (no. 1463), 6.

Tibia - fibula. (KUMVP no. 1464). This bone is represented by the distal half only, and has the epiphysis intact. It is much compressed, the width being 6 mm, the greatest thickness, 2.3 mm. There are two articular grooves, separated on the ventral surface by a raised tubercle. On the dorsal surface there is a narrow groove on the head. The dorsal line of the shaft is concave. The foramina on dorsal and ventral surfaces are separated by about 2 mm. The shaft is flattened, being 2 mm by 1.4 mm in its narrowest part. The groove separating the two elements is distinct on the ventral surface as far as the foramen, and to about half the distance to the tubercle, on the dorsal side.

Ilium. (KUMVP nos. 1465, 1466, 1467). Two bones, com-

plete except for the posterior tips, and belonging to the same individual, are referred. The elements are strongly curved, and have a longitudinal curved groove on the outer face. The inner face shows a curved groove near the upper border. There is a large, well-defined supra-acetabular tubercle. No. 1467 consists of the shaft only, and is from a slightly larger individual. The length of nos. 1465, 1466 is (both), 21.5 mm; the width of the head is 9 mm; the greatest diameter of the acetabular fossa is 5 mm.

Sacral vertebra. Two sacral vertebrae have been obtained from the "Edson beds" since the original description appeared. Figures of these are given (fig. 6). These agree with the type in general characters. The following measurements apply to the two sacra.

Measurements in mm of specimens nos. 1470, 1471

	<i>no. 1470</i>	<i>no. 1471</i>
Total width of fragment	11.5	14.
Width of right half (complete)	?	10.2
Length of centrum and condyle	3.	3.6
Combined condylar width	4.2	4.2
Space between base of condyles2	.4
Width of diapophysis at base	2.2	2.3
Width of diapophysis at termination	?	7.
Width of centrum	3.2	3.2
Width of arch (measured to long axis of body)	1.3	3.2
Depth of centrum	2.	2.4
Height of neural canal	1.	1.1
Posterior width of neural canal	3.	3.1

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GLOSSARY

This brief explanation of technical terms is given for use of readers who may not be acquainted with them.

acetabular head—Part of the thighbone that fits into acetabulum.

acetabulum—The cuplike cavity of the pelvis into which the thigh bone fits.

anchlyosed—Fused or solidly joined by bony growth.

angulare—A bone of the posterior part of the lower jaw.

Anura—A group of backboned animals that includes frogs and toads.

articulare—The posterior bone of the lower jaw.

centrum—The body of a vertebra.

coccyx—An elongate bone that terminates the vertebral column.

condyles—Slight projections from the skull with which the first vertebra is in contact.

coronoid—A small bone on the inner side of the lower jaw.

Crotaphytus—A genus of lizards, which includes the collared lizard or mountain boomer.

dentary—A bone in the anterior part of the lower jaw, which may bear teeth.

diapophyses—Bony projections from a vertebra to which a rib may attach.

diastema—A space or gap between the teeth.

epiphyses—Bony caps at the ends of the long bones, which normally fuse to the bone as the animal becomes adult.

foramina—Small openings in bones for passage of nerves and bloodvessels.

fossa—A groove or trench.

glenoid fossa—A cavity into which the bone of the upper arm fits.

matrix—The material in which a fossil is originally imbedded.

maxilla—Bone of the upper jaw.

Meckelian groove—A groove on the inner side of the dentary.

neotene—An animal that retains larval characters throughout its life.

neotenic—Having the characters of a neotene.

neuropophyses—Bony projections from the upper part of the vertebra.

notochord—A rod of cartilage that pierces the centrum of the vertebra during the early development of the larva, and may or may not persist in the adult.

notocoele—A cuplike cavity at the anterior or posterior end, or at each end of the centrum.

olecranon process—A curved bony projection at the end of the ulna.

parapophyses—Bony projections from the sides of the vertebrae.

Phrynosoma—A genus of lizards that includes the "horned-toads".

- pleurodont teeth—Teeth that are attached on the inner side of the jaw.
- Pliocene—A division of geologic time. Pliocene time is estimated as having begun about 7,000,000 years ago, and ended 2,500,000 years ago.
- premaxillary—A small bone in the anterior part of the lower jaw.
- prevomer—A bone in the roof of the mouth.
- prezygapophyses—Bony processes from the arch of the vertebra.
- procoelus—Referring to a vertebra having a cuplike notocoel at the anterior end.
- pulmonate mollusca—A group of invertebrate animals that include snails.
- radio-ulna—The bone of the arm, formed by the fusion of the radius and ulna.
- sacral vertebra—The vertebra to which the ilia attach.
- sigmoid—Having an S-shape.
- splénial—A bone of the inner side of the lower jaw.
- symphysis—The line of union between two bones.
- urostyle—A bone terminating the vertebral column; the coccyx.

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