Fossil Amphibians and Reptiles of Nebraska and Kansas

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Grant Nos. 1039, 1213, 1560. For study of amphibians and reptiles of northeastern Nebraska (upper Miocene and middle Pliocene) and of the WaKeeney local fauna (lower Pliocene) of Trego County, Kansas.

I. Research in Trego County, Kansas

The WaKeeney local fauna, Trego County, Kansas, has produced the largest lower Pliocene herpetofauna known. The collecting was done from a single site that represented a small stream basin filled with fine-grained cross-bedded sands. The WaKeeney local fauna was discovered by Lester F. Phillis in about 1941. After the discovery, parties from the University of Michigan and from the University of Kansas collected at the site, but these collections were made at the surface and no systematic excavations were attempted. In 1966 Richard L. and Jan Wilson removed about 250 "small" sacks of matrix (I interpret this as about 2½ tons) from the site and wet-screened the material in a nearby spring. The vertebrate fauna from the work was published by Wilson (1968). Shortly after, the Wilsons moved to the West Coast, and the late Dr. Claude W. Hibbard of the University of Michigan suggested that I continue excavations at the site, in view of the potentially large herpetofauna. Collecting was done in the summers of 1969, 1970, 1972, and 1973. The last two trips were financed by grants from the National Geographic Society.

Previously published references to the site include Hibbard and Phillis (1945), Hubbs and Hibbard (1951), Brodkorb (1962), Feduccia and Wilson (1967), Wilson (1968), Hibbard and Jammot (1971), and Holman (1971).

Location and Geology. All Michigan State material and most of the Wilsons' material came from a single site (UM-K6-59), which is on the Lowell Hillman Ranch 2,350-2,500 feet south and 75 feet east of the NW corner Sec. 22, R22W, T11S, Trego County, Kansas. The elevation at the site is 255 feet. The general regional picture of the area is as follows. The Saline River has eroded into the chalky limestone and calcareous shale beds of the Upper Cretaceous Niobrara Formation (upper Smoky Hill chalk member and lower

Fort Hays limestone members). The outcrops of these eroded beds form the "bluffs" that are the picturesque landmarks of the area. These Cretaceous beds are unconformably overlain by the Pliocene Ogallala Formation. The Ogallala beds are of unconsolidated clastic sediments which greatly vary in particle size. In this part of Kansas they are mainly unfossiliferous, but the WaKeeney site (UM-K6-59), representing a small basin in a stream in the Ogallala Formation, contains small vertebrate fossils. Above the Ogallala formation are Pleistocene sediments of eolian or fluviatile origin; overlying the Pleistocene sediments are Recent soils. Wilson (1968) figured a measured section through UM-K6-59.

Based on his study of the mammalian fossils of the site, Wilson (1968) believes that the WaKeeney is best assigned to the middle or late Clarendonian (lower Pliocene) provincial age.

Methodology. It was determined that the bones of the site were almost entirely confined to a cross-bedded sand lens that ranged in thickness from about 6 inches to about 3 feet. This lens, which averaged about 2 feet thick, was quarried laterally into the side of a hill until it finally gave way, in 1973, to unfossiliferous bluish clay. Material was gathered in burlap sacks, each containing about 45 pounds of matrix. A sample of one-half ton would be collected at each visit to the site, and this material was taken by truck to a nearby washing site on the Saline River or one of its tributaries. The material was then put on special wooden racks (Hibbard, 1949) to dry. The dried concentrate invariably contained small clay balls that had to be rewashed after they were thoroughly dried. After the clay balls were rewashed the concentrate was now ready to pick through for vertebrate fossils. Each field season our efficiency in processing matrix increased. The quantity processed in 1969 was 13.24 tons; in 1970, 20 tons; in 1972, 36 tons; and in 1973, 39 tons. In all, 75 tons of matrix were processed during the period of support by the National Geographic Society grants. In 1972 and 1973 we were greatly aided by use of a small front-end-loader for the removal of overburden.

Personnel. Student workers were key personnel in collecting the fossils. These include Merald Clark and William Rainey in 1969; Merald Clark, Bernie Franks, and Carl Steinfurth in 1970; James Fowler, Frederick Heineman, and Maria O'Hare in 1972; and Joseph Holman, Richard McArthur, Margaret Mead, Jason Potter, and Vincent Wilson in 1973. Dr. Robert Weigel of Illinois State University came out to the site and worked on the project in 1969, 1970, and 1972.

Location of WaKeeney Fossils Collected. WaKeeney fossils collected by Michigan State University have been placed in the Museum, Michigan State

University, and have been given Michigan State University-Vertebrate Paleontology numbers (MSU-VP). Dr. Robert Weigel of Illinois State University is studying the birds. The late Dr. Claude W. Hibbard of the University of Michigan and his student D. Jammot described two new shrews from the MSU WaKeeney material (Hibbard and Jammot, 1971); but the remainder of the mammalian material remains unstudied in the Museum at Michigan State University.

Scientific Results. A paper (Holman, 1975) on the WaKeeney local herpetofauna appeared in a volume in honor of the late Dr. Claude W. Hibbard. The WaKeeney local fauna yielded a herpetofauna consisting of at least 2 salamanders, 15 anurans, 5 turtles, 4 lizards, and 8 snakes. About half (48.2 percent) of these are indistinguishable from species living today, and most genera and families are extant, but some forms are holdovers from earlier times and some are unique to the fauna.

A checklist of the WaKeeney herpetofauna follows:

Class Amphibia
- Order Urodela
  - Family Ambystomatidae
    - *Ambystoma tigrinum* (Green)
    - *Ambystoma maculatum* (Shaw)
    - *Ambystoma* sp. indet.
- Order Anura
  - Family Pelobatidae
    - *Scaphiopus hardeni* Holman (new species)
  - Family Tregobatrachidae (new family)
    - *Tregobatrachus hibbardi* (new genus and species)
  - Family Bufonidae
    - *Bufo cognatus* Say
    - *Bufo marinus* (Linnaeus)
    - *Bufo hibbardi* Taylor
    - *Bufo pliocompactus* Wilson
    - *Bufo valentinensis* Estes and Tihen
  - Family Hylidae
    - *Acris* sp. indet.
    - *Hyla* cf. *H. cinerea* (Schneider)
    - *Hyla* cf. *H. gratiosa* LeConte
    - *Hyla* cf. *H. squirella* Sonnini and Latreille
    - *Hyla* sp. indet.
    - *Pseudacris* cf. *P. clarki* (Baird)
  - Family Ranidae
    - *Rana* cf. *R. areolata* Baird and Girard
    - *Rana* cf. *R. pipiens* Schreber
    - *Rana* sp. indet.

Class Reptilia
  Order Chelonia
    Family Kinosternidae
      Sternotherus odoratus (Latreille)
    Family Emydidae
      Terrapene cf. *T. carolina* (Linnaeus)
    Family Testudinidae
      Geochelone orthopygia (Cope)
      Geochelone sp.
    Family Trionychidae
      Trionyx sp. indet.
  Order Sauria
    Family Anguidae
      Ophisaurus attenuatus Baird
      Gerrhonotus mungerorum Wilson
    Family Teidae
      Cnemidophorus cf. *C. sexlineatus* (Linnaeus)
    Family Scincidae
      Eumeces hixsonorum Holman, new species
Order Serpentes
  Family Boidae
    Tregophis brevirachis Holman, new genus and species
    Ogmophis pliocompactus Holman, new species
  Family Colubridae
    Nerodia hillmani Wilson
    Thamnophis sp. indet.
    Paleoheterodon sp. indet.
    Coluber or *Masticophis*
    Elaphe sp. indet
    Lampropeltis similis Holman

Unique forms in the fauna include a new species of *Scaphiopus,* a new family, genus, and species of frog, a new species of *Eumeces,* a new genus of boid snake, a new species of *Ogmophis,* and an extinct species of watersnake *(Nerodia hillmani).* Modern species appearing for the first time in the fossil record include *Ambystoma maculatum, A. tigrinum, Bufo cognatus, Sternotherus odoratus, Terrapene* cf. *T. carolina, Ophisaurus attenuatus,* and *Cnemidophorus* cf. *C. sexlineatus.*

Habitats represented by the herpetofauna include a basin in a sluggish stream, a marshy area, mesophytic woodlands, and xerophytic woodlands. A subtropical climate with mild winters and temperatures seldom if ever reaching the freezing point and with vegetation similar to that of the Texas Gulf Coastal Plain today is indicated.

Differences between upper Miocene herpetofaunas in Nebraska and Saskatchewan and the WaKeeney local fauna were many, including (in the Wa-

Keeney) lack of large cryptobranchid salamanders, lack of xenosaurid lizards, lack of archaic natricine and colubrine snakes, and presence of large numbers of living species (about one-half).

II. Research in Northeastern Nebraska (1976)

At present I am involved in the study of herpetofaunas from temporally equivalent sites (upper Miocene, lower Valentine Formation) from north-central, northeastern, and southeastern Nebraska. It is hoped that ultimately a regional paleoecological picture of the amphibian and reptile life of this period of time over a broad geographical area in Nebraska may be presented.

Although I had been extensively involved in collecting fossils in north-central Nebraska before 1976, I had only briefly visited the sites in northeastern Nebraska in 1971 and 1974. Dr. Michael Voorhies, vertebrate paleontologist at the University of Nebraska State Museum, invited me to return to northeastern Nebraska in 1976 to excavate, personally, some of the fossils. For this purpose a grant was requested from the National Geographic Society and was funded.

When I arrived in Orchard, Nebraska, in August 1976, with two student assistants, Lisa Griggs and Mark Podell, the group was taken on a tour of sites in northeastern Nebraska by Dr. Voorhies. After some preliminary collecting at various sites, it was decided to concentrate collecting at the Annies Geese Cross (abbreviated AGC, representing upper Miocene) and Devils Nest Airstrip (abbreviated DNA, representing middle Pliocene) sites because they were both quite productive and could be worked effectively at the same time.

I am grateful to the National Geographic Society for providing the grant that funded this trip to northeastern Nebraska. My assistants in the field, Lisa Griggs and Mark Podell, rendered invaluable service. And I thank Dr. Michael Voorhies of the University of Nebraska State Museum, who helped our group in many ways and visited the site several times to lend a hand with the collecting.

THE ANNIES GEESE CROSS (AGC) SITE, UPPER MIOCENE

Location and Age. The AGC site was discovered by Dr. Michael Voorhies in a road-cut 10 miles northwest of Crofton, Knox County, Nebraska. Dr. Voorhies has been collecting fossil mammals from the site for several years, and plans to report on the geology and mammalogy of the site in a future publication. Dr. Voorhies's stratigraphic work has shown that the AGC site is equivalent in age to the lower part of the Valentine Formation and is thus of upper Miocene age.

Methodology. The matrix at the AGC site was a weakly cross-bedded, fine-grained sand that was rather wet when quarried. Thus, a washing and screening technique was used to collect the fossils. Matrix was dug out of the bank at the site, put into burlap bags, and then transported by truck to a shallow bay at the nearby Lewis and Clark Reservoir. Here the matrix was washed through boxes with screen sides and bottoms, a process similar to the one described by Hibbard (1949). The concentrate from the matrix was then sun-dried after being placed on towels on top of a large tarp. When the concentrate was dry it was sorted through for fossils in the trailer which was rented as our base of operation.

A list of fauna from the AGC site as of May 11, 1978, follows:

Class Amphibia
Order Anura
Family Pelobatidae
Scaphiopus sp. (Spadefoot)
Material: Ilia and sacrococcyges
Remarks: This small burrowing frog probably lived in sandy areas on land. The bones are most similar to those of *Scaphiopus bombifrons*, a common frog of the High Plains of the United States today.
Family Hylidae
Hyla sp. (Tree Frog)
Material: Ilia
Remarks: The ilia are similar to those of several modern tree frogs of small to moderate size, but specific determinations await further study.
Family Bufonidae
Bufo sp. (Small Toad)
Material: Ilia
Remarks: Several ilia indicate the presence of small toads, quite contrasting in size to the "giant toad" ilia found at the DNA site.
Family Ranidae
Rana sp. (Grass Frog)
Material: Ilia
Remarks: These ilia indicate a small species of *Rana* very similar to the modern leopard frog, *Rana pipiens*. The presence of this species indicates a grassy marsh in the proximity of the site.
Class Reptilia
Order Squamata
Family Iguanidae
Leiocephalus sp. (Curly-Tailed Lizard)
Material: Dentaries
Remarks: Mr. Carl Wellstead has reported on these important fossils in his master's thesis at the University of Nebraska and plans to discuss them in a forthcoming publication. The genus *Leiocephalus* is confined to the West Indes today, except for a small colony which has been introduced into Florida. The present-day tropical distribution of this lizard indicates that the climate of northeastern Nebraska must have been

much warmer in upper Miocene times than at the present.

Family Colubridae

Paleoheterodon tiheni (Extinct Hognose Snake)

Material: Trunk vertebrae

Remarks: This snake has specialized rear-teeth that were very long and knifelike for puncturing the bodies of inflated toads. An almost complete specimen of this snake was recently reported from the upper Miocene of southeastern Nebraska (Holman, 1977). This is the first published record of this genus and species for northeastern Nebraska.

Elaphe sp. (Rat Snake)

Material: Trunk vertebrae

Remarks: The presence of a rodent-eating snake in the fauna is not surprising in the light of the occurrence of small rodents among the mammalian fossils from AGC.

Thamnophis sp. (Gartersnake or Ribbonsnake)

Material: Trunk vertebrae

Remarks: This snake genus has species that are often found in grassy or marshy areas.

THE DEVIL'S NEST AIRSTRIP (DNA) SITE, MIDDLE PLIOCENE

Location and Age. The DNA site was discovered by Dr. Michael Voorhies and occurs in the eroded surface of an abandoned airstrip at the Devil's Nest development Area 12 miles north-northwest of Crofton, Knox County, Nebraska. Dr. Voorhies has been collecting fossil mammals from the site for several years and plans a report on the geology and mammalogy of the locality. Dr. Voorhies's stratigraphic work has shown that the fossil-bearing bed is a Hemphillian (middle Pliocene) channel in the Valentine Formation.

Methodology. Collecting methods at the DNA site included picking up material at the surface of this extensive deposit and dry-screening at the site. This fitted very well into our schedule, as we could visit the DNA site during times when we were waiting for the AGC concentrate to dry or on weekends. The DNA site turned out to be rich in vertebrate fossils, especially in turtle material.

A list of fauna from the DNA site as of May 11, 1978, follows:

Class Amphibia

Order Anura

Family Bufonidae

Bufo sp. (Giant Toad)

Material: Ilia

Remarks: This is an important fossil find for the material represents a toad that appears to be identical to the modern "giant toad," *Bufo marinus,* which today ranges from extreme southern Texas south into Mexico and Central America. The presence of this species also indicates a much warmer climate for northeastern Nebraska in the middle Pliocene than at present.

Family Ranidae

Rana sp. (Grass Frog)

Material: Ilia
Remarks: This frog, also very similar to the modern leopard frog, *Rana pipiens,* indicates the presence of a grassy marsh in the area.
Class Reptila
Order Chelonia
Family Chelydridae
Chelydra sp. (Snapping Turtle)
Material: Shell fragments
Remarks: This species indicates the presence of a slow-moving or still permanent body of water.
Family Emydidae
Pseudemys sp. (Cooter or Slider Turtle)
Material: Nuchal plates and other shell material
Remarks: The presence of these large aquatic turtles indicates the presence of a permanent body of water, probably a slow-moving river or large pond.
Clemmys sp. (Spotted Turtle Relative)
Material: Nuchals and shell matrial
Remarks: These turtles are semiaquatic and today live in grassy marshes.
Family Testudinidae
Geochelone sp. (Small Rugose Land Tortoise)
Material: Numerous pieces of shell
Remarks: This rough-shelled small land tortoise is certainly a member of the "tugida" group of *Geochelone* species. This group was rather widespread in the High Plains of North America in the late Tertiary.
Family Trionychidae
Trionyx sp. (Softshelled Turtle)
Material: Several pieces of shell
Remarks: This is perhaps the most aquatic genus of freshwater turtles living in the United States today so a permanent body of water, probably a slow-moving river, stream, or a pond, is indicated.
Order Squamata
Family Teidae
Cnemidophorus sp. (Racerunner Lizard)
Material: Dentary
Remarks: The lizards of this genus all live in sandy habitats today, thus such a habitat must have been in the vicinity of the fossil site in the middle Pliocene.
Family Colubridae
? *Heterodon* (Hognose Snake)
Material: Vertebrae
Remarks: At this time I am not sure whether this isolated vertebral material represents the extinct genus *Paleoheterodon* or the living genus *Heterodon.* Modern hognosed snakes prefer dry, sandy habitats.
Salvadora sp. (Patchnosed Snake)
Material: Trunk vertebrae
Remarks: This genus occurs hundreds of miles to the south of the area today and thus is another form that indicates a warmer climate for northeastern Nebraska in the middle Pliocene. Members of this genus mainly prefer dry, terrestrial habitats today.

Elaphe sp. (Ratsnake)
Material: Trunk vertebrae
Remarks: This rodent-eating species probably fed on mice and small rats that were present as substantiated by the mammalian fossils from the DNA site.

GENERAL CONCLUSIONS

On the basis of herpetological fossils identified, it would appear that northeastern Nebraska had a much warmer climate in both the middle Pliocene and upper Miocene than at present. I would venture to guess that the climate was similar to that of the Gulf Coast of Texas today. Certainly the Curly-Tailed Lizard in the AGC fauna and the "Giant Toad" and southern turtles and snakes in the DNA fauna would indicate such a possibility.

The depositional environments of the two sites appear to be different. The weakly cross-bedded, small-grained sand that forms the AGC matrix would indicate a low energy transport situation, possibly a small "hole" in a gently flowing stream. The lack of animals with permanently aquatic habits might indicate a seasonal stream or pond. A dry, sandy, terrestrial habitat is also indicated by some of the AGC herpetofauna.

On the other hand, the large number of turtles that require a permanent aquatic habitat at the DNA site indicate the presence of a permanent large stream, river, or pond. Other faunal elements also indicate the presence of a rather dry, perhaps sandy, terrestrial habitat.

PRESENT STATUS OF THE PROJECT

At present (1980), several people are continuing to study the AGC and DNA material collected in 1976.

1. Carl Wellstead (whose University of Nebraska master's thesis discusses lizards of the AGC site) is preparing a report on upper Miocene lizards which will detail some of the AGC *Leiocephalus* material.

2. Dale Jackson, a graduate student at the University of Florida, is studying the aquatic emydid turtles from the DNA site.

3. J. Alan Holman is studying the remainder of the herpetological material from both sites and will incorporate Wellstead's and Jackson's work into a final publication on the amphibians and reptiles of the two faunas.

4. Michael Voorhies of the University of Nebraska State Museum is studying the mammalogical material from the site.

One of the most spectacular finds, if not the most spectacular find, in the 1976 collection from the DNA site was the complete skull of the large insectivore, *Meterix (Plesiosorex)*. Dr. Voorhies has informed me that this is the only skull known of this animal that has been known previously only on the basis of

teeth. This hedgehog-size insectivore has been illustrated by University of Nebraska artists and will be featured in a separate scientific publication because of its importance.

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