The Hottell Ranch rhino quarries (basal Ogallala: medial Barstovian), Banner County, Nebraska. Part I: Geologic setting, faunal lists, lower vertebrates

M. R. VOORHIES — *Division of Vertebrate Paleontology, University of Nebraska State Museum, Lincoln, Nebraska 68588*

J. ALAN HOLMAN — *The Museum, Michigan State University, East Lansing, Michigan 48824*

XUE XIANG-XU — *Department of Geology, Northwestern University, Xian, Shaanxi, People's Republic of China*

ABSTRACT

Numerous fossil rhinoceros remains were quarried from the Hottell Ranch sites in the southwestern Nebraska Panhandle during the 1940's but no paleontological study of the locality has been published. Renewed collecting at the quarries, including screenwashing, has resulted in recovery of a diverse and abundant sample of vertebrates comprising fishes (3 species), amphibians (9 species), reptiles (14 species), birds (unstudied), and mammals (50+ species) from basal Ogallala sediments at the main sites. An age of medial Barstovian (approximately 14 million years) is indicated by a mammalian fauna judged to post-date the Lower Snake Creek Fauna (early Barstovian) and to pre-date most of the later Barstovian faunas from the Valentine Formation in north-central Nebraska. A less diverse late Barstovian fauna was collected from strata directly superposed on the principal fossiliferous unit. The herpetofauna from the sites is taxonomically close to other Barstovian assemblages from the Great Plains (especially the quarry samples from Norden Bridge, Egelhoff, Myers Farm, Kleinfelder Farm and Bijou Hills) but differs in 1) lacking boid snakes and 2) having comparatively few remains of fishes or other aquatic vertebrates. Many of the fossils are water-rolled suggesting considerable transportation; however, the lack of associated igneous and metamorphic pebbles indicates that the paleo-stream that deposited the fossiliferous sediment did not have its headwaters in the nearby Laramie Range, but was a local, perhaps ephemeral, drainage. A mild paleoclimate, with frost-free winters, is suggested by the presence of large tortoises (*Geochelone*) and the curl-tail lizard (*Leiocephalus*). Both forested areas and open grasslands are inferred to have been present near the site of deposition.

INTRODUCTION

Important collections of mammalian fossils representing the Barstovian North American Land Mammal Age (Wood, et al., 1941) have long been known from the Pawnee Buttes area of northeastern Colorado (Matthew, 1901; Galbreath, 1953) and faunas of approximately equivalent age recently have been reported from southeastern Wyoming (Cassiliano, 1980). In Nebraska (Fig. 1), the classic Lower Snake Creek Fauna (Matthew, 1924; Skinner et al., 1977) is probably the best-represented early Barstovian fauna in North America while the faunas of the Crookston Bridge Member of the Valentine Formation in northcentral Nebraska (Skinner and Johnson, 1984) are collectively the best-preserved samples of the late Barstovian (or early "Valentinian") vertebrate biota on the continent. There are no published indications, however, that Barstovian vertebrates occur south of the Platte River, in southwestern Nebraska, and it is the purpose of this paper to place such an occurrence on record. The fossils discussed here were collected from a cluster of sites on the Hottell Ranch in west-central Banner County, Nebraska (Fig. 2).

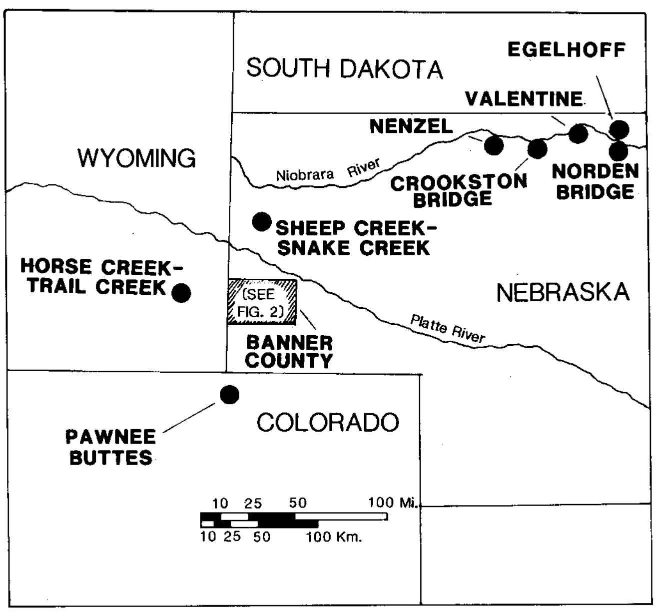


Figure 1. Map of western Nebraska and adjacent areas showing location of important Barstovian faunal sites in relation to Banner County study area.

The scant mention of the Hottell Ranch quarries in the paleontological literature belies their importance. Tanner (1960) published a photograph of a composite mounted skeleton of *Peraceras* from sites Bn 10 and Bn13 (see below) and has figured several isolated incisors and postcranial elements of *Teleoceras* from Bn 10 (Tanner, 1975, Figures 3 and 4). However, the geology and paleontology of the sites has not been previously discussed in print.

HISTORY OF COLLECTING

Field records of the University of Nebraska State Museum (UNSM) indicate that fossils were first discovered on the Andrew Hottell Ranch by S. R. Sweet, T. C. Middleswart, and W. F. Chaloupka, amateur collectors who collaborated with UNSM paleontologists over a period of many

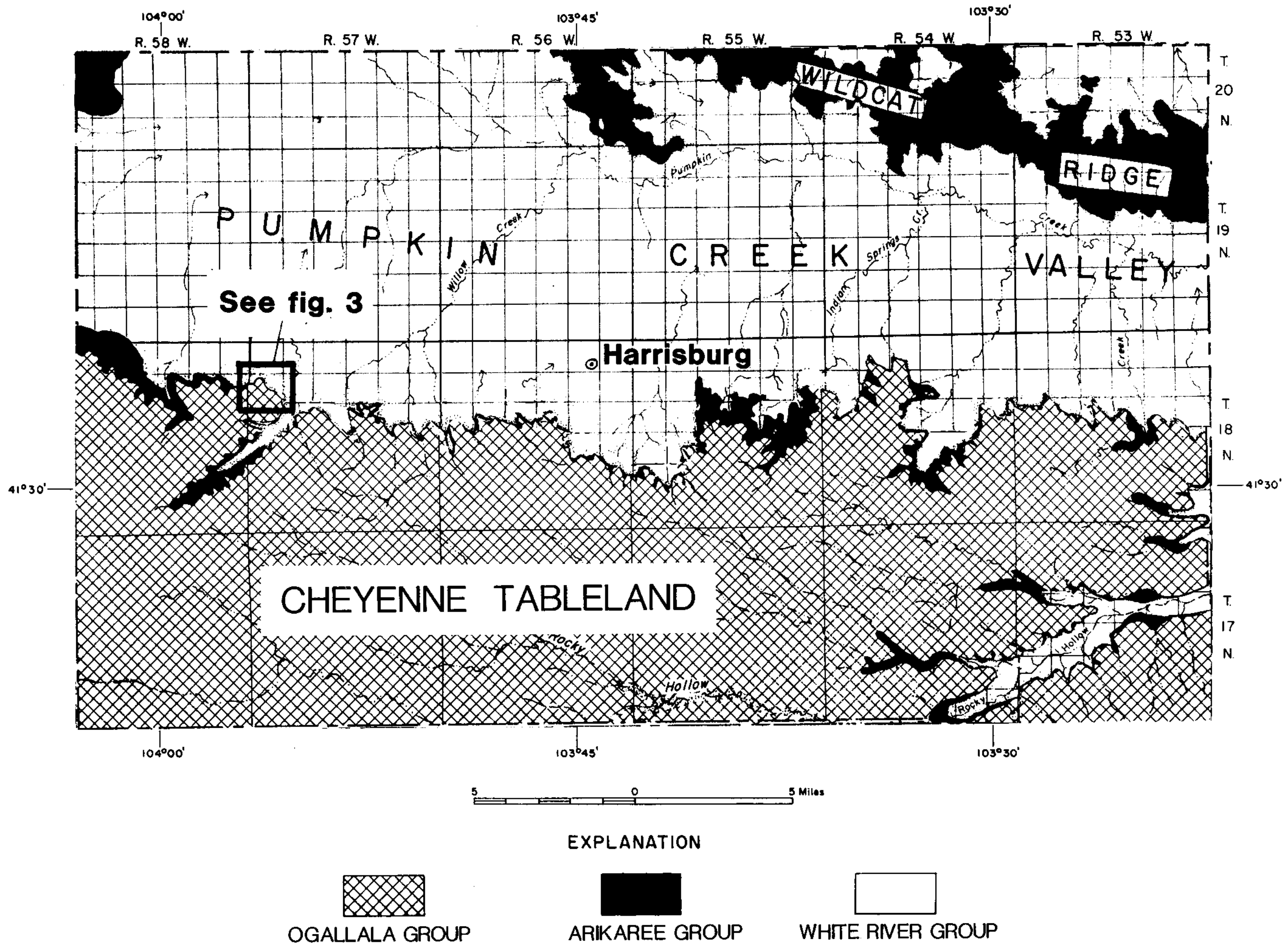


Figure 2. Geologic map of Banner County, Nebraska with Hottell Ranch study area outlined. Modified from Smith and Souders (1975) and Swinehart et al. (1985).

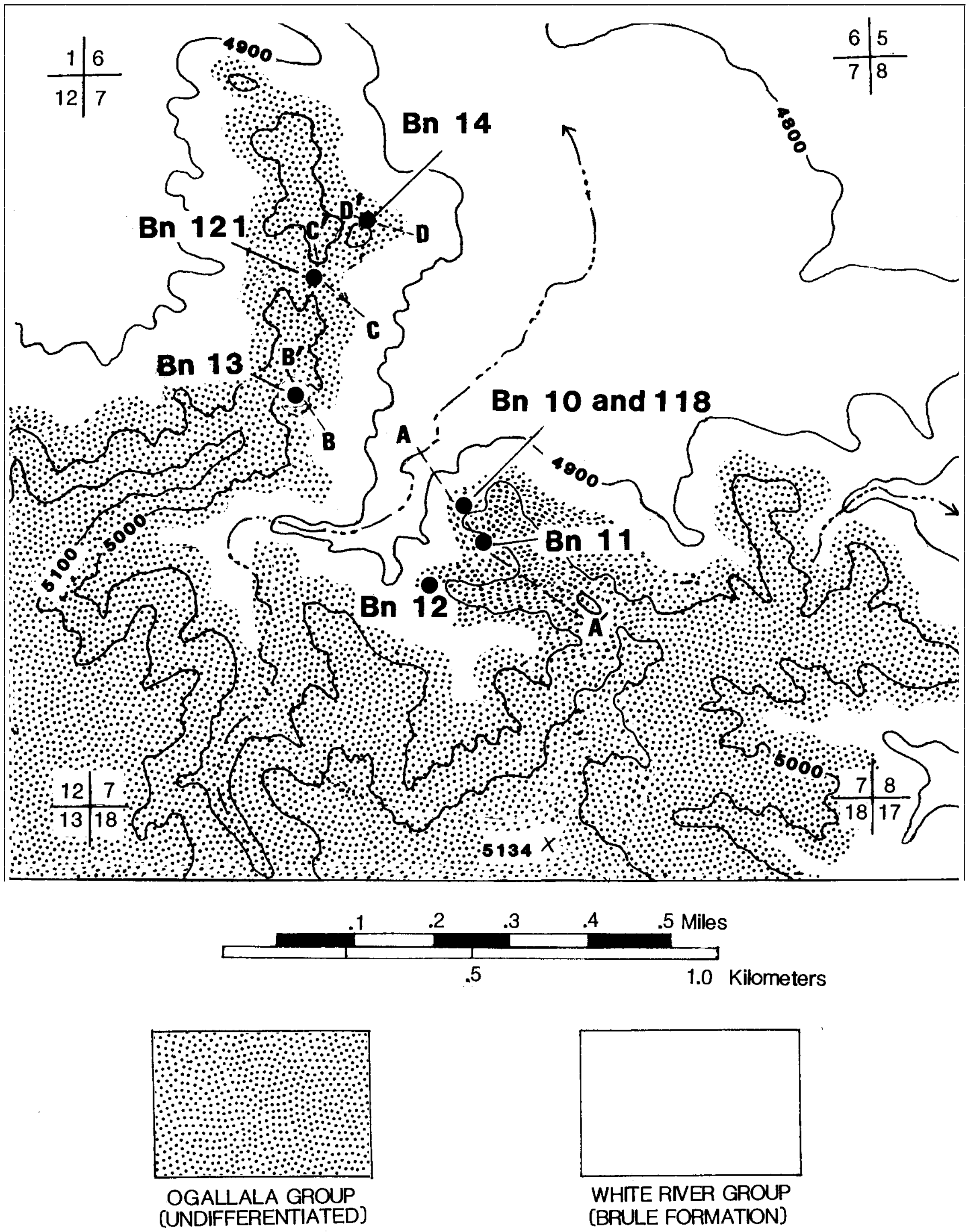
years beginning in the 1930's. The trio collected a number of well-preserved remains of large mammals, including a nearly complete skull and mandible of a large rhinocerotid, from the Hottell pasture in 1936 and 1937. Initially, three small quarries were opened: 1) a "Carnivore Quarry" (now designated locality Bn 12 in Museum records); 2) a "Rhinoceros Quarry" (Bn 13); and 3) a "Mastodon Quarry" (Bn 14). Further excavations at the three original sites and at two new ones—Bn 10 ("Main Quarry") and Bn 11 ("Horse Quarry")—were carried out by UNSM field parties in the 1940's. By far the most productive site was Bn 10 which produced 571 numbered specimens to a party led by R. S. Kubicek in 1946 and 66 specimens to a party led by H. P. Reider in 1947. Disarticulated remains of two genera of rhinocerotids, *Teleoceras* and *Peraceras*, are overwhelmingly the most abundant fossils in the collection from Bn 10, accounting for more than 95% of the specimens recovered.

Sporadic visits by Museum personnel during the 1950's through 1970's resulted in the collection of a few specimens but no further intensive work at Hottell Ranch was carried out until 1982 when two of the authors (MRV and XX-X), accompanied by G. W. Brown, visited the area. We relocated the previously worked quarries through the use of field notes and photographs preserved in the UNSM archives, especially a sketch map prepared by W. D. Frankforter in 1946 showing the locations of sites Bn 10 through Bn 14. Clearly discernible excavations and associated backdirt mounds still mark the sites of the five original quarries and we were able to plot their locations on the Murray Lake SW Quadrangle, USGS 7½ minute topographic series (Fig. 3).

We attempted no further work at sites Bn 10, 12, 13, or 14 but did collect a 200 kg sample of fossiliferous lithic gravel at Bn 11 for screenwashing and also collected a similar-sized sample at a new site, Bn 121, ("Corner's Gap"). Most of our field effort, however, was expended at a new excavation, Bn 118 ("Immense Journey Quarry"), developed approximately 15 meters south of Bn 10. Remains of both large and small vertebrates are abundant at Bn 118. All three sites worked in 1982 yielded identifiable lower vertebrate fossils, which are described under "Systematic Paleontology" below.

Although vegetative cover prevents determination of precise lateral and vertical relationships of all seven quarry sites, our work shows that all lie within the basal 15 meters

 Contributions to Geology, University of Wyoming, v. 25, no. 1, p. 55-69, 9 figs., 3 tables, May, 1987



GEOLOGY of
Sec. 7, T 18 N, R 57 W Banner County, Nebr.
showing location of Hottell Ranch Quarries

Figure 3. Geology of Hottell Ranch area showing vertebrate fossil sites and location of geologic sections A-A′, through D-D′. Geographic and topographic base from Murray Lake SW Quadrangle, U.S.G.S. 7½″ Topographic Series, 1979.

of a valley-filling sand and gravel unit assignable to the Ogallala Group (undifferentiated).

LOCATION AND STRATIGRAPHY

The study area is located approximately 16 km west of Harrisburg and 10 km east of the Wyoming line (Fig. 2) in sec. 7, T. 18 N., R. 57 W. The fossil quarries lie near the base of the predominantly north-facing escarpment that forms the boundary between the Cheyenne Tableland, which underlies most of southern Banner County, and the broad valley of Pumpkin Creek, which occupies the central and northwestern portions of the county. The Cheyenne Tableland is a remnant of a high plain, "the Gangplank," that slopes eastward from the Laramie Range in southeastern Wyoming into western Nebraska. It stands from 60 to 80 meters above the adjacent valley of Pumpkin Creek and its northern edge affords excellent exposures of Tertiary strata.

The broad outlines of Banner County geology have been clear since the time of N. H. Darton whose geologic map of Nebraska west of the 103rd meridian (1899, plate 84) shows three flat-lying Tertiary units underlying the county; in ascending order these were listed as the Brule Clay, Arikaree Formation, and Ogallala Formation. All three units were shown as cropping out continuously along the northern edge of the Cheyenne Tableland.

A. L. Lugn's (1939, plate 1) map of the Tertiary geology of western Nebraska is very similar to Darton's in its interpretation of Banner County but differs in three respects. Lugn raised Darton's Ogallala to group rank and showed two map units within the formation along the northern margin of Cheyenne Tableland and elsewhere: an upper unit consisting of the Kimball Formation and the Sidney Gravel and a lower comprising the Ash Hollow and Valentine Formations. He likewise divided the Arikaree into two map units—an upper, the Harrison Formation, and a lower, the Gering and Monroe Creek Formations—but showed only the lower map unit in Banner County. Finally, whereas Darton's map shows a continuous band of Arikaree along the escarpment bounding the Cheyenne Tableland, Lugn's shows an interruption of the Arikaree in T. 18 N., R. 57 W. Lower Ogallala rocks (Valentine-Ash Hollow) are shown resting directly on the Brule clay in this area, which includes the site of the Hottell Ranch quarries. Significantly, the quarries had been discovered in 1936 (see above) and may have been visited by Lugn, who worked closely with Museum personnel, prior to preparation of his map (drafted in 1938, see Lugn, 1939, plate 1).

The next geologic map of Banner County to appear was produced by Smith and Souders (1975) as part of a report on groundwater geology. Published at a somewhat larger scale (1:250,000) than previous maps, and based on much new subsurface and surface information, the 1975 map differs in detail from earlier ones regarding the distribution of both the Arikaree and the Ogallala Groups, neither of which is subdivided. The Arikaree outcrop band is shown as less continuous than on previous maps, and a pair of accompanying cross-sections (Smith and Souders, 1975, Fig. 9) shows that pre-Ogallala erosion has removed the Arikaree from much of the area underlying the Cheyenne Tableland. A still more recent study of Banner County geology (Swinehart et al., 1985) has further restricted the Arikaree in southern Banner County and assigned many deposits formerly placed in the Arikaree to a newly recognized formation within the White River Group. Figure 2 of the present paper is based on Smith and Souders (1975) map as modified by the work of Swinehart et al. (1985).

The only detailed study of the Ogallala Group in Banner County has been published by Diffendal (1985) who mapped portions of the 3 townships immediately to the east of that including the Hottell Ranch site. In this area, south of the town of Harrisburg, Diffendal has shown that the Ogallala can be subdivided into: 1) an older sand and gravel fill; 2) a younger sand and gravel fill which cuts across the older fill; 3) small tributary fills; and 4) a complex fill of great age range. Diffendal's interpretation contrasts sharply with that of Lugn (1939) who described and mapped the Ogallala as a succession of widespread, sheetlike units (Valentine, Ash Hollow, Sidney, Kimball) which could be traced laterally for great distances. Working a few miles west of the area mapped by Diffendal, we also failed to find evidence for "layer-cake" geology within the local Ogallala section. We have therefore followed Diffendal and others

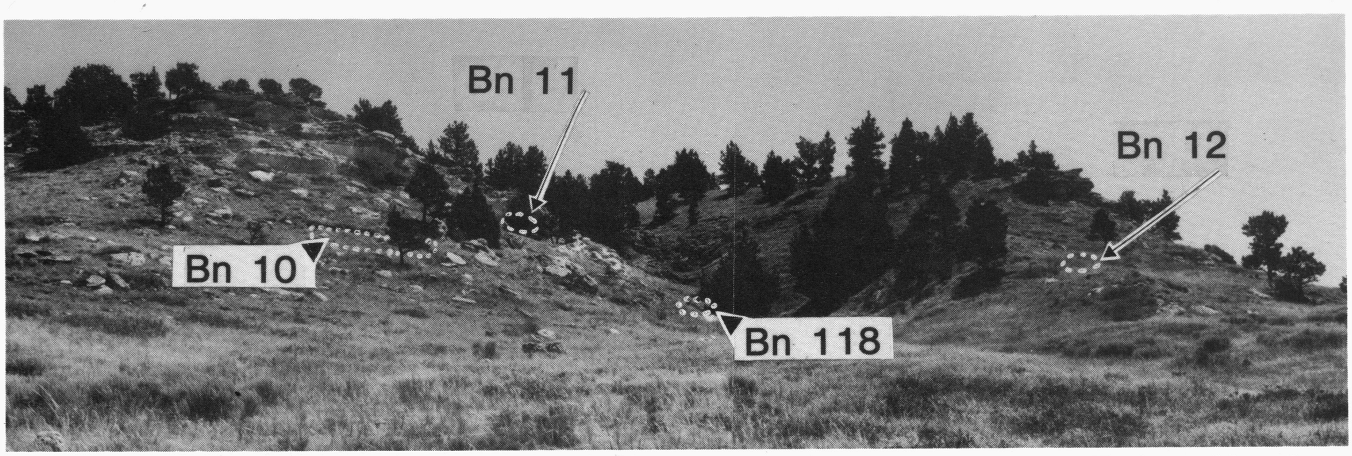


Figure 4. Ogallala exposures on northern edge of Cheyenne Tableland on Hottell Ranch showing location of fossil quarries. View is toward the south.

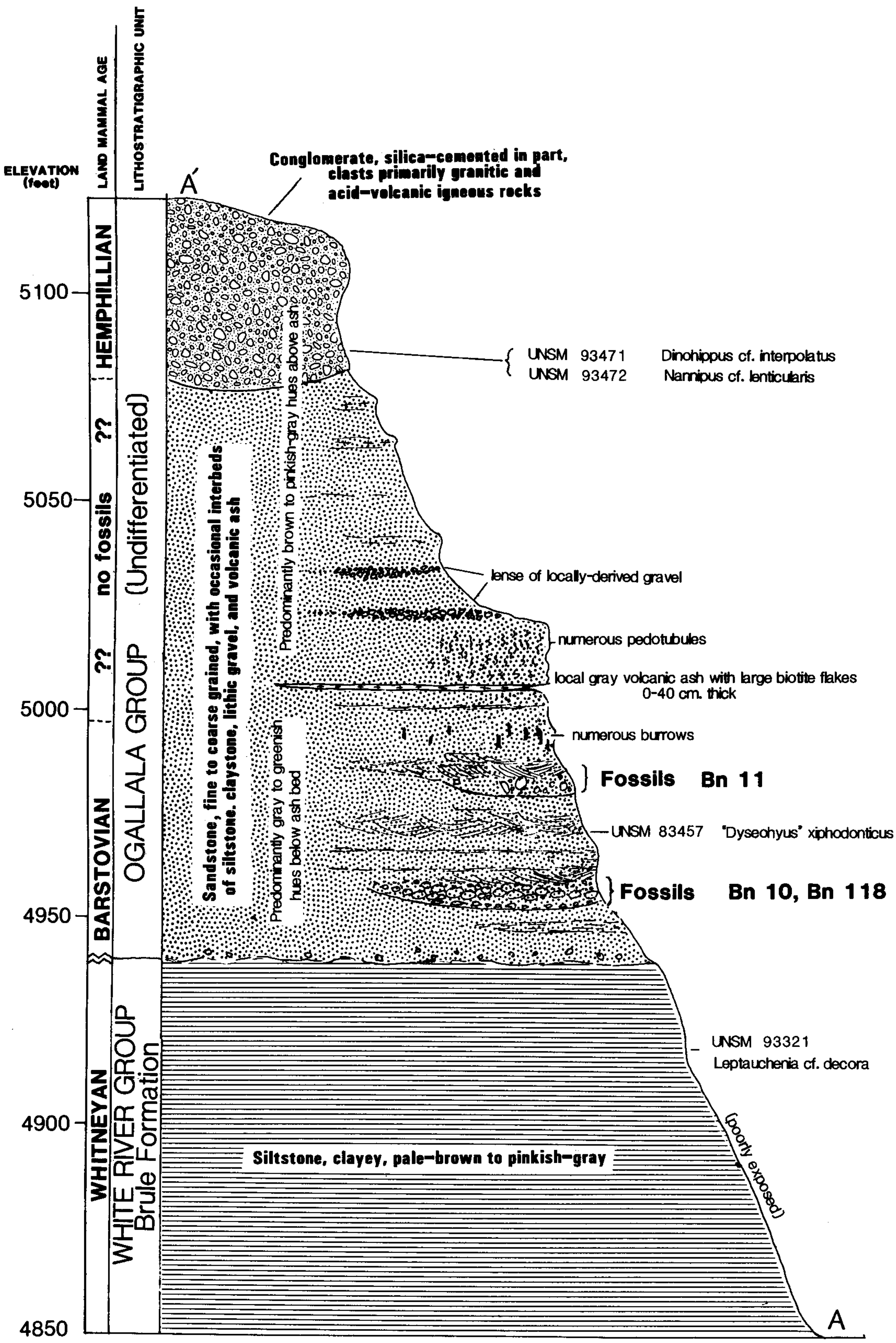


Figure 5. Geologic section A-A′ showing stratigraphic relationship of quarries Bn 10 and Bn 118 (medial Barstovian) and Bn 11 (late Barstovian).

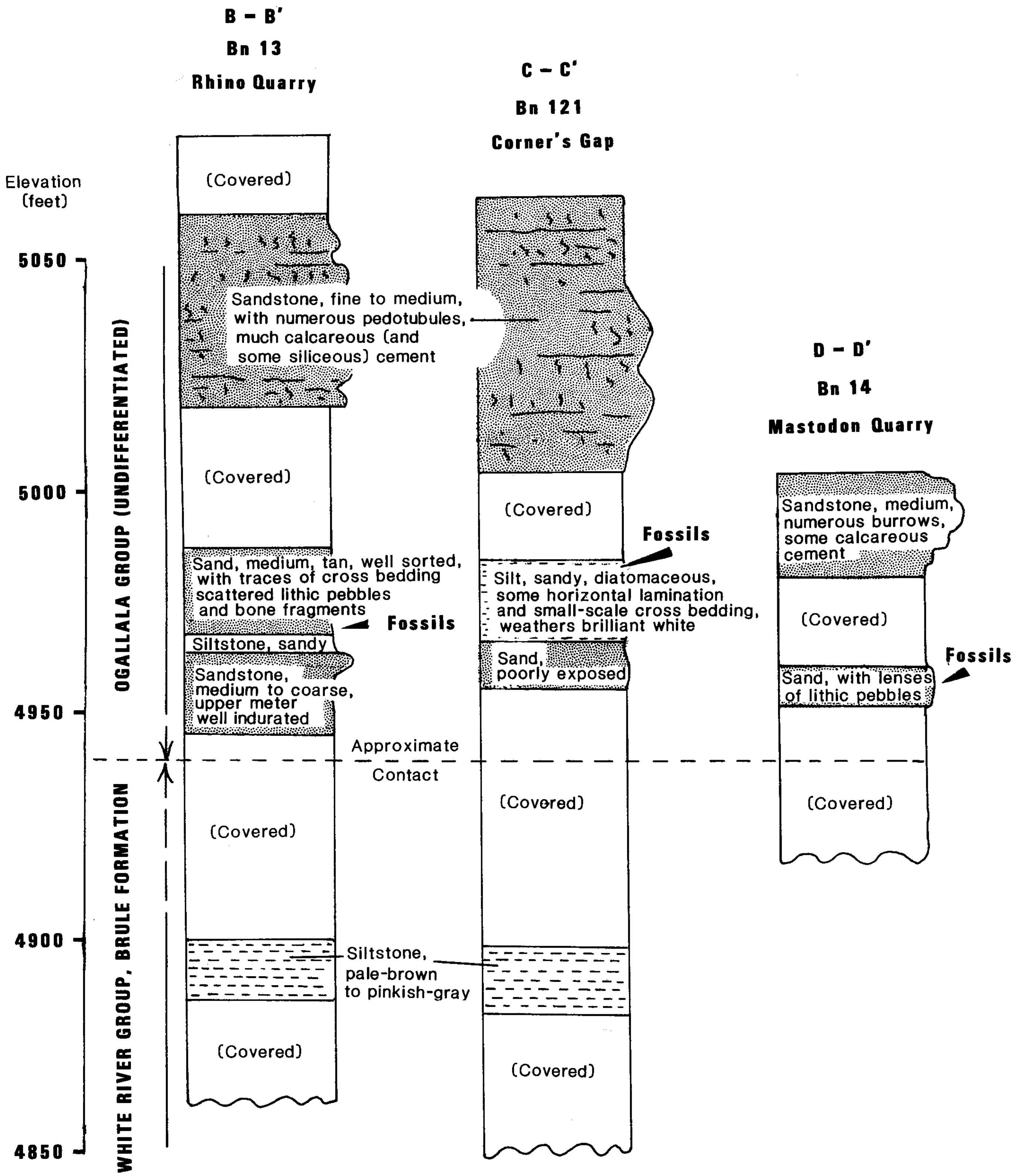


Figure 6. Geologic sections B-B′ through D-D′, showing stratigraphic relationships of Hottell Ranch quarries Bn 13, 14 and 121, all medial Barstovian.

(e.g. Swinehart et al., 1985) in rejecting the use of formally-named formational units for the Ogallala rocks in our study area.

The Hottell Ranch quarries are located on both sides of a short canyon that drains northeastward from the Cheyenne Tableland into Pumpkin Creek Valley (Fig. 3). Only the Brule Formation, a pinkish-brown, massive siltstone, and the Ogallala Group, consisting primarily of sandstone but also including finer and coarser sediment, are locally exposed. Arikaree rocks have been totally removed by pre-Ogallala erosion. Swinehart et al. (1985) have used subsurface data to identify a SW-NE-trending basal Ogallala paleovalley in the Hottell Ranch area.

Field work by two of the authors (MRV and XX-X) showed that the Ogallala/Brule disconformity occurs at an elevation of approximately 4940 feet in the vicinity of the fossil quarries (Figs. 5 and 6). Locally, the Ogallala can be broken into two informal lithologic units. The lower unit, in which all of the fossil quarries occur, lacks distant source gravels but the upper unit, which caps the local section, has a great abundance of igneous and metamorphic pebbles. Anorthosite clasts in the upper Ogallala gravel indicate a source area in the Laramie Range (Stanley, 1974). Fossils are not abundant in this upper unit but several horse teeth diagnostic of the Hemphillian North American Land Mammal Age were collected from it during the present study (Fig. 5).

In the vicinity of quarries Bn 10, 11, 12, and 118 (Fig. 4), the lower portion of the Ogallala can be further subdivided into two subunits, a basal portion characterized by abundant lenses of cross-bedded, locally-derived gravel and an upper portion containing only a few lenses of pebbles and fewer primary sedimentary structures. All four fossil quarries occur in the lowermost 15 meters of the Ogallala, below a lense of volcanic ash; however, site Bn 11 is in a channel stratigraphically higher than the other three quarries. The quarries were excavated in coarse-grained, poorly sorted channel deposits characterized by large clasts of locally-derived siltstone up to 25 cm in diameter. Many fossils from the lower three sites show evidence of extensive abrasion. For example, the sample of vertebrate fossils collected from approximately 1.5 M^3 of gravel at site Bn 118 during the 1982 field season weighs 187 kg of which 176 kg (94%) consists of unidentifiable fragments assignable to the "well rounded" or Stage 3 category of Hunt (1978). Fossils from the higher channel (Bn 11) in contrast show little or no abrasion (Stages 0-1 of Hunt).

The remaining three sites, Bn 13, 14, and 121 lie on the opposite side of the valley where the Ogallala section is less complete and less well exposed. They are also close to the basal Ogallala unconformity (Fig. 6). Sites Bn 13 and 14 are now badly slumped but both quarries appear to have been excavated in unconsolidated, cross-bedded sand containing lenses of lithic pebbles. Site Bn 121, in contrast, consists of a lenticular accumulation of diatomaceous, sandy silt. Fossils recovered from this unit show little or no evidence of abrasion.

FAUNAL LISTS

A total of 93 vertebrate taxa are now recognized from the sites (Table 1) and more will undoubtedly be added as studies of the mammals, now in progress, are completed. Only the fishes, amphibians, and reptiles are treated systematically in this report. Nearly all of these "lower vertebrates" belong to taxa previously described from assemblages in the Valentine Formation and its approximate correlatives in Nebraska, South Dakota, and elsewhere on the Great Plains. Among the faunas with which comparisons of the Hottell Ranch fossils were made are: Norden Bridge Quarry (Estes and Tihen, 1964; Holman, 1973b, 1982), Egelhoff Quarry (Chantell, 1971; Holman, 1973a), Myers Farm (Holman 1977a), Valentine Railway Quarry (Holman and Sullivan, 1981), Glenn Olson Quarry (Green and Holman, 1977), South Bijou Hill (Holman, 1978), Kleinfelder Farm (Holman, 1970), and Trinity River (Holman, 1977b).

BIOCHRONOLOGY

The presence of an extremely large rhinoceros tentatively identified as *Aphelops* (Tanner, 1960) in the early collections from Hottell Ranch led to the assignment of a Hemphillian age to the assemblage (Tanner, 1975). However, the much more diverse and abundant collections now available (Table 1) strongly point to a much earlier (Barstovian) age. Mammalian taxa identified from the quarries which are not known to occur elsewhere in pre- or post-Barstovian assemblages include: *Domninoides valentinensis, Russellagus, Eucastor tortus, Perognathus trojectioansrum, Megasminthus, Hypohippus osborni, Neohipparion republicanus, Teleoceras medicornutus, "Dyseohyus" xiphodonticus, Blastomeryx gemmifer, Merycodus warreni,* and *Ramoceros.* Lower vertebrate taxa that may be biochronologically significant include the salamander *Ambystoma minshalli* and the snake *Elaphe nebraskensis*, which are also restricted to deposits of Barstovian age (see species accounts below).

No radiometric date is yet available for the volcanic ash overlying the Hottell Ranch quarries; therefore, the age of the latter must be estimated on the basis of the fauna alone. A more detailed assessment of the placement of the Hottell quarries within the Barstovian will be possible when studies of the mammals are completed. For present purposes we offer the following conclusions regarding intra-Barstovian chronology:

1) The presence of proboscidean remains in the quarries indicates an age later than early Barstovian. The early Barstovian Lower Snake Creek Fauna and its correlatives (e.g. Trinity River) are characterized by a lack of proboscideans (Skinner et al., 1977).
2) The mammalian assemblage from the most productive of the Hottell sites (Bn 10 and Bn 118) most closely resembles that from Norden Bridge Quarry, the stratigraphically-lowest site in the Valentine Formation in north-central Nebraska (Skinner and Johnson, 1984). The Norden Bridge assemblage is assigned to the medial Barstovian by Voorhies (in press).
3) The stratigraphically highest of the Hottell quarries, Bn 11, produces a fauna more similar to that from the Valentine Railway Quarry and other sites of late Barstovian age.

Table 1. FAUNAL LISTS, HOTTELL RANCH QUARRIES.

	Taxa	Bn 10 Main Quarry	Bn 11 Horse Quarry	Bn 12 Carnivore Quarry	Bn 13 Rhino Skull Q.	Bn 14 Mastodon Quarry	Bn 118 Immense Journey Q.	Bn 121 Corner's Gap	
OSTEICHTHYES	Lepisosteus sp.							•	Fishes
	Amia sp.						•	•	
	Ictalurus sp.		•				•	•	
AMPHIBIA	Ambystoma minshalli						•	•	Salamander
	Scaphiopus wardorum						•		Frogs and Toads
	Scaphiopus cf. bombifrons						•		
	Bufo cf. hibbardi						•		
	Bufo valentinensis						•		
	Bufo sp.						•		
	Hyla form A						•		
	Hyla form B						•		
	Rana pipiens complex		•				•	•	
	Rana near clamitans						•		
REPTILIA	Geochelone sp.	•	•	•	•	•	•		Turtles
	Emydinae gen. et sp. indet.		•				•	•	
	Trionyx sp.						•		
	Leiocephalus sp.						•		Lizards
	Sceloporus sp.						•		
	Eumeces sp.						•		
	Gerrhonotus sp.							•	
	Paleoheterodon tiheni						•		Snakes
	Dakotophis greeni						•	•	
	Elaphe nebraskensis		•				•	•	
	Lampropeltis similis						•		
	Salvadora paleolineata						•	•	
	Nerodia sp.						•		
	Thamnophis sp.		•						
MAMMALIA	Plesiosorex cf. donroosai						•		Insectivorans
	Untermannerix copiosus						•		
	Parvericius montanus						•	•	
	Metechinus amplior						•	•	
	Heterosorex sp.						•		
	Soricidae gen. et sp. indet.						•		
	Mystipterus sp.						•		
	Scalopoides sp.						•		
	Domninoides sp.						•	•	
	Domninoides valentinensis		•						
	Chiroptera, fam., gen. et sp. indet.						•		Bat
	Hesperolagomys cf. fluviatilis						•		Lagomorphs
	Russellagus cf. vonhofi						•	•	
	Hypolagus cf. parviplicatus						•	•	
	Hypolagus sp.		•						
	Leporidae gen. et sp. indet.	•							
	Allomys sp.						•		Rodents
	Mylagaulus cf. laevis						•		
	Mylagaulus cf. monodon		•						
	Miospermophilus sp.						•		
	Sciuridae gen. et sp. indet.		•				•	•	
	"Monosaulax" curtus						•		
	Monosaulax cf. pansus						•	•	
	Eucastor tortus		•				•		
	Eomyidae gen. et sp. indet						•		
	Perognathus trojectioansrum						•		
	Perognathus cf. furlongi						•		
	Cupidinimus nebraskensis		•				•	•	
	Peridiomys rusticus						•		
	Parapliosaccomys sp.						•		
	Copemys cf. niobrariensis		•				•		
	Macrognathomys sp.						•		
	Megasminthus cf. gladiofex						•	•	
	Megasminthus tiheni		•						
	Tomarctus sp.		•				•		Carnivorans
	Aelurodon cf. ferox		•						
	Leptocyon sp.						•		
	Amphicyonidae gen. et sp. indet.	•		•			•		
	Martes (Plionictis) ogygia							•	
	Pseudaelurus sp.					•	•		
	Gomphotherium sp.	•	•		•	•	•		Proboscideans
	Zygolophodon sp.					•			
	Hypohippus osborni	•					•		Perissodactyls
	Parahippus cognatus	•	•				•		
	Merychippus insignis	•	•				•		
	Neohipparion republicanus	•	•				•		
	Protohippus sp.	•					•		
	Pliohippus cf. mirabilis		•						
	Calippus cf. placidus		•						
	Chalicotheriidae gen. et sp. indet.						•		
	Tapiravus sp.						•		
	Peraceras crassus	•	•	•	•	•	•		
	Teleoceras medicornutus	•	•		•		•		
	"Dyseohyus" xiphodonticus	•	•				•		Artiodactyls
	Merycoidodontidae gen. et sp. indet.	•	•				•		
	Aepycamelus sp.			•	•		•		
	Protolabis cf. heterodontus					•	•		
	Protoceratidae gen et sp. indet.						•		
	Pseudoparablastomeryx sp.						•		
	Dromomerycidae gen. et sp. indet.	•					•		
	Cranioceras (Procranioceras) skinneri		•						
	Blastomeryx gemmifer		•				•		
	"Submeryceros" minor	•					•		
	Merycodus sp.	•		•			•	•	
	Merycodus warreni		•						
	Ramoceros cf. osborni		•						

Contributions to Geology, University of Wyoming, v. 25, no. 1, p. 55-69, 9 figs., 3 tables, May, 1987

Our assessment of the ages of the Hottell quarries relative to other Barstovian sites that have produced important collections of lower vertebrate fossils is shown in Table 2.

Table 2. CORRELATION OF GREAT PLAINS BARSTOVIAN FAUNAS HAVING SIGNIFICANT LOWER VERTEBRATE COMPONENT.

M.Y. B.P.		TEXAS	NEBRASKA	SOUTH DAKOTA	SASKATCHEWAN
12					
	LATE		Myers Farm Valentine Railway Bn 11*		
13					
	MEDIAL	Town Bluff	Egelhoff Norden Bridge	Glenn Olson Q South Bijou Hill	Kleinfelder Farm
14			Bn 121* Bn 118*		
15	EARLY	Trinity River			
16					

* Hottell Ranch quarries, this paper; references for other faunas in text.

Table 3. RELATIVE ABUNDANCE OF BOIDS IN BARSTOVIAN SNAKE FAUNAS (see text for discussion).

Fauna	Boid Specimens Identified	Total Snake Specimens Identified	Boids / All Snakes	References
Kleinfelder Farm	26	42	62%	Holman, 1970
Glenn Olson	1	4	25%	Green and Holman, 1977
Myers Farm	200	850	24%	Holman, 1977a
Texas Gulf Coast	2	14	15%	Holman, 1977b
South Bijou Hill	5	37	14%	Holman, 1978
Norden Bridge	2	30	7%	Holman, 1964, 1982
Egelhoff	3	55	5%	Holman, 1973
Valentine Railway	0	5	0	Holman and Sullivan, 1980
Hottell Ranch	0	92	0	This Paper

SYSTEMATIC PALEONTOLOGY

Class OSTEICHTHYES

We follow the classification used by Estes and Tihen (1964).

Order AMIIFORMES
Family AMIIDAE
Genus *Amia* Linnaeus, 1766
Amia sp. indet.

Referred specimens: UNSM 93572, three vertebrae from Bn 118; UNSM 93498, four vertebrae from Bn 121.

Comments: These specimens are referred to *Amia* on the basis of their short anteroposterior length, broad amphicoelous cotyles, and presence of pits for aortal supports on their ventral sides. They are also perforated centrally as in most vertebrae in a Recent *Amia calva* skeleton examined by the authors.

Order LEPISOSTEIFORMES
Family LEPISOSTEIDAE
Genus *Lepisosteus* Lacèpéde, 1803
Lepisosteus sp.

Referred specimens: UNSM 93499, vertebra and scale from Bn 121.

Comments: A small gar is represented by these specimens. The diamond-shaped ganoid scale is covered with smooth enameloid. The opisthocoelous vertebra bearing paired neural spines is readily distinguished from that of all other freshwater fishes.

Order OSTARIOPHYSI
Family ICTALURIDAE
Genus *Ictalurus* Rafinesque, 1820
Ictalurus sp.

Referred specimens: UNSM 93561, three fragmentary pectoral spines and two vertebrae from Bn 11; UNSM 93571, nine fragmentary pectoral spines and two vertebrae from locality Bn 118; UNSM 93500, seven spines, one dentary, and twelve vertebrae from Bn 121.

Comments: Catfish ranging from approximately 5 cm to 30 cm in standard length are indicated by this material. Placement in *Ictalurus* is based on pectoral spine anatomy. The spine shafts are finely striate and the anterior ridge is prominent. Where not removed by abrasion, uniformly-spaced, evenly-retrorse, single-cusped dentations are present anteriorly. The more complete spines are indistinguishable from those of Recent *I. punctatus* but more material is required for positive specific identification. The strongly amphicoelous vertebrae (readily distinguished thereby from both *Amia* and *Lepisosteus*) are tentatively assigned here on the basis of their marked similarity to Recent *I. punctatus* vertebrae.

Class AMPHIBIA Linnaeus, 1758

The classification and order of appearance of taxa in this section mainly follows Dowling and Duellman (1978).

Order CAUDATA Oppel, 1811
Family AMBYSTOMATIDAE Hallowell, 1856
Genus *Ambystoma* Tschudi, 1838
Ambystoma minshalli Tihen and Chantell, 1963

Referred specimens: UNSM 93583, three vertebrae from Bn 118; UNSM 93488, four vertebrae from Bn 121.

Comments: These vertebrae conform to the description and dimensions of *A. minshalli* (Chantell, 1971; Tihen and Chantell, 1963), a small salamander with elongate vertebral proportions. This extinct species is believed to be related to the *A. maculatum* group of Tihen (1958). It has been previously reported from several Barstovian localities in the

Valentine Formation in Nebraska (Type Valentine: Holman and Sullivan, 1981; Egelhoff fauna; Chantell, 1971; Holman, 1976b; Norden Bridge fauna; Tihen and Chantell, 1963; Estes and Tihen, 1964; Holman, 1982) and from the late Barstovian of South Dakota (Glenn Olson quarry, Green and Holman, 1977; Bijou Hills fauna, Holman, 1978). Today, salamanders of the *A. maculatum* group are mainly woodland forms.

Order SALIENTIA Laurenti, 1768
Family PELOBATIDAE Stannius, 1856
Genus *Scaphiopus* Holbrook, 1836
Scaphiopus wardorum Estes and Tihen, 1964

Referred specimens: UNSM 93596, one left and two right ilia from Bn 118.

Comments: This is a relatively large form of *Scaphiopus* with a well-developed dorsal ilial prominence. It has previously been reported from the Valentine Formation in Nebraska (Egelhoff fauna: Chantell, 1971; Norden Bridge fauna: Estes and Tihen, 1964; Holman, 1976b). This extinct form is rather similar to *S. holbrooki*, a species that presently lives in eastern woodlands.

Scaphiopus cf. *Scaphiopus bombifrons* Cope, 1863

Referred specimens: UNSM 93597, two left and six right ilia from Bn 118.

Comments: This is a relatively small form with an obsolete to absent dorsal ilial prominence. It occurs at the same localities as *S. wardorum* above. Today, *S. bombifrons* occurs in the grasslands of central United States (Conant, 1975, map 252).

Family BUFONIDAE Fitzinger, 1826
Genus *Bufo* Laurenti, 1768
Bufo cf. *Bufo hibbardi* Taylor, 1936

Referred specimens: UNSM 93591, two right ilia from Bn 118.

Comments: These are moderately large ilia with moderately high to quite high and irregularly shaped dorsal ilial prominences. This species has previously been tentatively identified from medial Barstovian sites in the Valentine Formation of Nebraska (Egelhoff fauna: Chantell, 1971; Norden Bridge fauna: Estes and Tihen, 1964; Holman, 1973b).

Bufo valentinensis Estes and Tihen, 1964

Referred specimens: UNSM 93593, five left and eight right ilia from Bn 118.

Comments: Thirteen small ilia with low ilial prominences appear identical to *B. valentinensis* (Estes and Tihen, 1964, Fig. 2b, p. 458). This species has also been previously reported from a number of sites in the Valentine Formation of Nebraska (Estes and Tihen, 1964; Chantell, 1971; Holman, 1973b).

Bufo sp. indet.

Referred specimens: UNSM 93595, one left and three right ilia from Bn 118.

Comments: These small *Bufo* ilia have quite high dorsal ilial prominences. They may represent *B. hibbardi* or an undescribed species.

Family HYLIDAE Hallowell, 1857
Genus *Hyla* Laurenti, 1768
Hyla form A

Referred specimens: UNSM 93609, left ilium from Bn 118.

Comments: This *Hyla* ilium appears to be almost identical to a specimen (Chantell, 1964, Fig. 4c, p. 220) assigned to *Hyla* cf. *H. squirella* from the Norden Bridge fauna. The specimen represents a moderately small *Hyla* with a dorsolateral dorsal protuberance that is small, oval, and raised, and with the anterior edge even with the anterior border of the acetabular fossa.

Hyla form B

Referred specimens: UNSM 93604, two right ilia from Bn 118.

Comments: We are unable to assign these ilia to the specific level but they appear to represent a taxon distinct from that listed above as "*Hyla* form A." The dorsal protuberance is rounded and is located quite far from the dorsal border of the acetabulum, and in one specimen the ventral acetabular expansion (Chantell, 1964, Fig. 1) is quite extensive.

Family RANIDAE Bonaparte, 1831
Genus *Rana* Linnaeus, 1758
Rana pipiens complex

Referred specimens: UNSM 93586, one left and one right ilium from Bn 11; UNSM 93587, 11 left and six right ilia from Bn 118; UNSM 93492, two left and three right ilia, and one sacrum from Bn 121.

Comments: These ilia represent frogs of the *Rana pipiens* complex, a group containing the leopard frogs and pickerel frogs, whose modern species are being continually revised, and which all have similar ilia. All have the posterior border of the ilial crest sloping gently into the dorsal acetabular expansion and lack a rounded or roughened tuber superior (terminology of Bohme, 1982, Fig. 2). Frogs of this complex have been reported from so many Miocene localities in the Great Plains that it is pointless to report them all here.

Rana sp. near *Rana clamitans* Latreille, 1802
Fig. 7

Referred specimens: UNSM 93590, left ilium from Bn 118.

Comments: This is the first time a frog morphologically similar to *R. clamitans* has been reported from deposits as old as Barstovian, although a somewhat similar, but much smaller ilium, identified only as "*Rana* sp." was reported from the Town Bluff local fauna (Barstovian of Texas) by Holman (1977b). Whether the Hottell Ranch ilium represents a species ancestral to *R. clamitans* or *R. clamitans* itself is

Contributions to Geology, University of Wyoming, v. 25, no. 1, p. 55-69, 9 figs., 3 tables, May, 1987

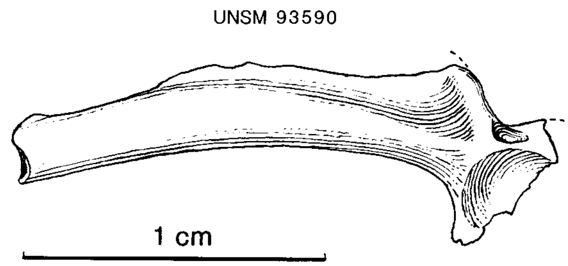


Figure 7. ***Rana*** **near** ***clamitans*****, left ilium, locality Bn 118, medial Barstovian, Banner County, Nebraska.**

conjectural. The ilium is of moderately large size, has a steep slope of the dorsal ilial crest into the dorsal acetabular expansion, but lacks the roughened tuber superior of this area seen in most *R. catesbeiana*.

Class REPTILIA Laurenti, 1768

The classification and order of appearance of taxa in this section mainly follows Dowling and Duellman (1978).

Order TESTUDINES Batsch, 1788
Family TESTUDINIDAE Gray, 1825
Genus *Geochelone* Fitzinger, 1835
Geochelone sp. indet.

Referred specimens: UNSM 93610, carapace fragments from Bn 10; UNSM 93608, left scapula, left coracoid, 2 left humeri, right radius, 2 left and 1 right femur, right pubis, phalanx, dermal plates from Bn 11; UNSM 93607, carapace fragments from Bn 12; UNSM 93606, dermal plate from Bn 13; UNSM 93605, dermal plate from Bn 14; UNSM 93614, left scapula, right tibia, fragmentary left femur, undetermined limb fragments, phalanx, and dermal plates from Bn 118.

Comments: The size of these elements indicates that a large species such as *Geochelone orthopygia* is represented in all but one of the Hottell Ranch quarries (Bn 121). However, considering the present lack of knowledge of variation in large Barstovian *Geochelone*, we have not attempted specific identification of this material. This genus is very widespread in Tertiary deposits in North America and is thought to indicate mild, frost free winter climates (Hibbard, 1960). Two of the tortoise bones from locality Bn 11, the coracoid and pubis, display well-defined circular punctures between 5 and 10 mm in diameter, evidently made by predatory or scavenging mammals.

cf. Emydinae gen. et sp. indet.

Referred specimens: UNSM 93600, fragmentary shell elements from Bn 11; UNSM 93611, carapacial fragments and partial nuchal of a juvenile from Bn 118; UNSM 93613, carapacial fragments and fragmentary limb girdle element from Bn 121.

Comments: These specimens either represent juvenile individuals or are too fragmentary for generic or specific identification.

Family TRIONYCHIDAE Gray, 1825
Genus *Trionyx* Geoffrey, 1809
Trionyx sp. indet.

Referred specimens: UNSM 93612, carapacial fragment from Bn 118.

Comments: This fragment has the characteristic dorsal sculpturing of this genus which is extremely common in Tertiary deposits in North America. The fragment is from a juvenile individual and it is impossible to determine which species is represented.

Order SQUAMATA Oppel, 1811
Family IGUANIDAE Gray, 1827
Genus *Leiocephalus* Gray, 1827
Leiocephalus sp. indet.
Fig. 8

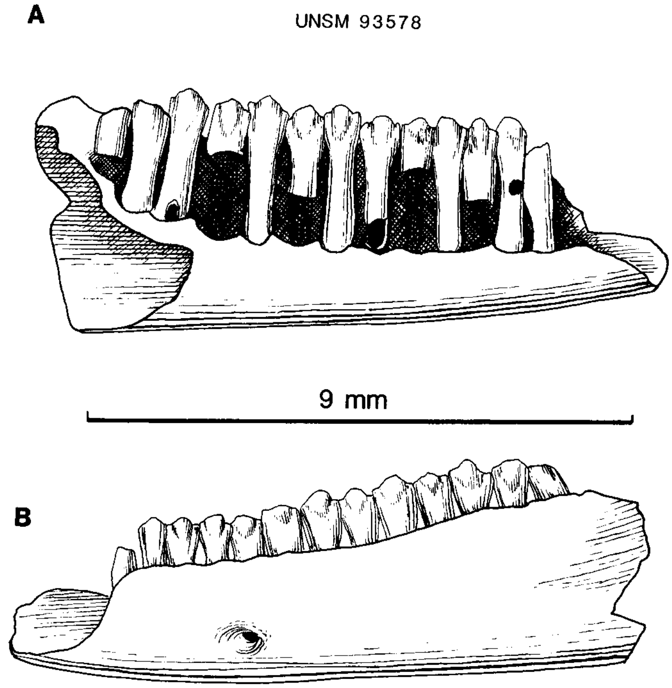


Figure 8. ***Leiocephalus*** **sp., left dentary, locality Bn 118, medial Barstovian, Banner County, Nebraska.** ***A*** **= lingual view.** ***B*** **= labial view.**

Referred specimens: UNSM 93578, left dentary; UNSM 93579, one left and one right dentary and one left maxilla, all from Bn 118.

Comments: The teeth in these dentaries appear to be more closely spaced distally and not so constricted basally as those in a form named *Leiocephalus nebraskensis* (formerly *N. septentrionalis*, see Wellstead, 1983) by Wellstead (1982, Fig. 1, p. 366) from Barstovian localities in Nebraska. The Hottell Ranch specimens also differ in this regard from a dentary referred to as *Leiocephalus* sp. by Holman and Sullivan (1981, Fig. 4) from the type section of the Valentine Formation (late Barstovian, northcentral Nebraska), presumably the same form named by Wellstead. Whether the new fossils represent a distinct species or an age or seasonal tooth variation of *L. nebraskensis* is unknown at present.

Genus *Sceloporus* Wiegmann, 1828
Sceloporus sp. indet.

Referred specimens: UNSM 93573, right dentary from Bn 118.

Comments: This dentary appears to represent the unicuspid species described, but not named, by Wellstead (1982) in his report on lizards from several Barstovian localities in the Valentine Formation of northern Nebraska (see Wellstead, 1982, Fig. 2abc, p. 370).

Family SCINCIDAE Gray, 1825
Genus *Eumeces* Wiegmann, 1834
Eumeces sp. indet.

Referred specimens: UNSM 93577, right dentary from Bn 118.

Comments: This dentary has an open Meckelian groove and unicuspid terminally striated teeth. It represents the genus *Eumeces*, but we are unable to determine the species. Wellstead (1982) identified *Eumeces* sp. indet. from several Barstovian localities in Nebraska.

Family ANGUIDAE Gray, 1825
Genus *Gerrhonotus* Wiegmann, 1828
Gerrhonotus sp. indet.

Referred specimens: UNSM 93497, a fragment of a maxilla with three teeth from Bn 121.

Comments: The teeth in this fragment are large, terminally bilobate with the anterior lobe more elevated than the posterior one as in modern *Gerrhonotus*. This fragment is not complete enough for specific identification. The genus has previously been reported from Norden Bridge and Egelhoff quarries in the Valentine Formation of north-central Nebraska (Holman and Sullivan, 1981).

Sauria fam. et gen. indet.

Referred specimens: UNSM 93582, fragmentary left and two fragmentary right dentaries; maxillary fragment, and three vertebrae from Bn 118.

Family COLUBRIDAE Cope, 1895
Genus *Paleoheterodon* Holman, 1964
Paleoheterodon tiheni Holman, 1964

Referred specimens: UNSM 93534, five vertebrae from Bn 118.

Comments: This genus and species was described on the basis of vertebral remains from Norden Bridge Quarry (Holman, 1964). A relatively complete skeleton from a late Barstovian site in south-central Nebraska allowed for a revised diagnosis based on more skeletal parts (Holman, 1977a). This genus has been found in Miocene deposits in both Kansas and Nebraska (Holman, 1979) and has recently been recognized in Europe (Rage and Holman, 1984). As in the modern genus *Heterodon, Paleoheterodon* had specialized elongate teeth for puncturing and deflating toads of the genus *Bufo*.

Genus *Dakotaophis* Holman, 1976
Dakotaophis greeni Holman, 1976

Referred specimens: UNSM 93563, three vertebrae from Bn 118; UNSM 93484, one vertebra from Bn 121.

Comments: This genus was described by Holman (1976a) from Black Bear Quarry II (Hemingfordian of South Dakota) on the basis of vertebral remains. It is a very small colubrine with a relatively short and wide vertebral form. The neural spine and hemal keel are thin and the vertebrae never bear epizygapophyseal spines. Besides the type locality, *D. greeni* is known from Hemingfordian age localities in Wyoming (Split Rock) and Nebraska (Marsland Quarry) and from the early Barstovian of Texas (Trinity River). The only previously reported medial Barstovian record of the taxon was in the Bijou Hills local fauna (Fort Randall Formation) of South Dakota (Holman, 1978). No late Barstovian or later occurrences are known (Holman, 1979).

Genus *Elaphe* Fitzinger, 1843
Elaphe nebraskensis Holman, 1964

Referred specimens: UNSM 93554, forty-three vertebrae that appear to be from a single small individual from Bn 11; UNSM 93537, seven vertebrae from Bn 118; UNSM 93474, seven vertebrae from an adult individual from Bn 121.

Comments: This species was described from the Norden Bridge fauna by Holman (1964). It is an *Elaphe* that reaches a rather large size and that has a neural spine somewhat longer than high as in modern *Elaphe vulpina*. All known occurrences of this species are Barstovian but they are geographically widespread (Saskatchewan, South Dakota, Nebraska, Texas, see Holman, 1979).

Genus *Lampropeltis* Fitzinger, 1843
Lampropeltis similis Holman, 1964

Referred specimens: UNSM 93553, two vertebrae from Bn 118.

Comments: This small species, possibly ancestral to the later *Lampropeltis intermedius* and perhaps also related to the living species *L. triangulum*, *L. pyromelana*, and *L. zonata*, was originally described from the Norden Bridge Quarry. Vertebrae of this snake have a depressed neural arch, a low to obsolete neural spine, and a relatively wide, not highly produced hemal keel. This species has previously been reported from Barstovian localities in Saskatchewan, South Dakota and Nebraska, and the Clarendonian Wakeeney local fauna of Kansas (Holman, 1979).

Genus *Salvadora* Baird and Girard, 1853
Salvadora paleolineata Holman, 1973

Referred specimens: UNSM 93532, six vertebrae from Bn 118; UNSM 93479, three vertebrae from Bn 121.

Comments: This extinct species was described on the basis of vertebral remains from the Egelhoff fauna, basal Valentine Formation, medial Barstovian, of northcentral Nebraska (Holman, 1973a). This species is very similar to modern species of the genus except that it does not have as well-developed epizygapophyseal spines. This is a common

Contributions to Geology, University of Wyoming, v. 25, no. 1, p. 55-69, 9 figs., 3 tables, May, 1987

Miocene snake that has been reported from Hemingfordian through Barstovian deposits in Wyoming, South Dakota, Nebraska, and Texas (Holman, 1979).

Genus *Nerodia* Baird and Girard, 1853
Nerodia sp. indet.

Referred specimens: UNSM 93538, nine vertebrae from Bn 118.

Comments: These vertebrae have the shortened vertebral form and well-developed, non-truncated hypapophysis of the genus *Nerodia.* We are unable to determine what species they represent, although it appears to be a small one. *Nerodia* sp. has been recorded from the Miocene of Nebraska, Kansas, and Texas (Holman, 1979).

Genus *Thamnophis* Fitzinger, 1843
Thamnophis sp. indet.
Fig. 9

Referred specimens: UNSM 93559, vertebra, UNSM 93560, three vertebrae, from Bn 11.

Comments: These are the most complete *Thamnophis* vertebrae we have seen from Miocene deposits in North America. These fossils have the moderately short vertebral form and anteriorly and posteriorly undercut neural spine of modern *Thamnophis radix* and *T. marcianus.* We are unable to say whether this form represents one of these species or is ancestral to one or both of them. Holman (1977a) reported *Thamnophis* sp. from the late Barstovian Myers Farm local fauna of southeastern Nebraska. The Myers Farm vertebrae, along with those reported here from an assemblage of equivalent age, appear to be the oldest occurrences of the genus on record. *Thamnophis* is known from later Miocene assemblages in Kansas and Oklahoma (Holman, 1979).

DISCUSSION

The assemblages of fish, amphibian, and reptilian remains identified from the most productive Hottell Ranch sites (Bn 11, 118, 121) are most similar in overall composition to those reported from the lower part of the Valentine Formation in north-central Nebraska (Estes and Tihen, 1964; Holman, 1976b, 1982). We note, for example, that only one (*Rana* near *clamitans*) of the 20 taxa described from Bn 118 (the richest site) has not been collected at both Norden Bridge Quarry and Egelhoff Quarry, which are judged to be of slightly younger biochronological age than Bn 118, but still medial Barstovian (see Table 2). The small size of the Hottell Ranch samples, compared to the much more extensive ones from Norden Bridge and Egelhoff, probably accounts for the relatively small number of species recorded at the former compared to the latter sites. We suggest, however, that two differences may not be due to chances of sampling. First, the scarcity of fish remains at the Hottell sites is striking. Only 45 fragmentary specimens representing three taxa are present compared with several thousand specimens assigned to 14 species in the Norden Bridge Quarry sample (Smith, 1962; Estes and Tihen, 1964; Voorhies, in press). Fish remains make up about 30% of the identifiable micro-vertebrate fossils from Norden Bridge Quarry (Voorhies, in press) and similar estimates apply to many other fluvial micro-vertebrate assemblages of Barstovian age with which we are familiar. In contrast, the 45 Hottell specimens make up less than 2% of the specimens identifiable to class (2850). The low frequency of fishes and other strictly aquatic vertebrates, such as *Trionyx*, in the Hottell assemblage may indicate that the stream which deposited the fossiliferous sands and gravels was not a permanent one. This interpretation is supported by the absence of distant-source clasts in the channel gravels containing the fossils.

A second contrast with other Barstovian herpetofaunas is the absence of boids among the identifiable snake remains in the Hottell collection. Members of the now mostly tropical family Boidae are rather common elements in most described quarry samples (Table 3), but do not occur in the available sample from Hottell Ranch. We are unable to account for this discrepancy.

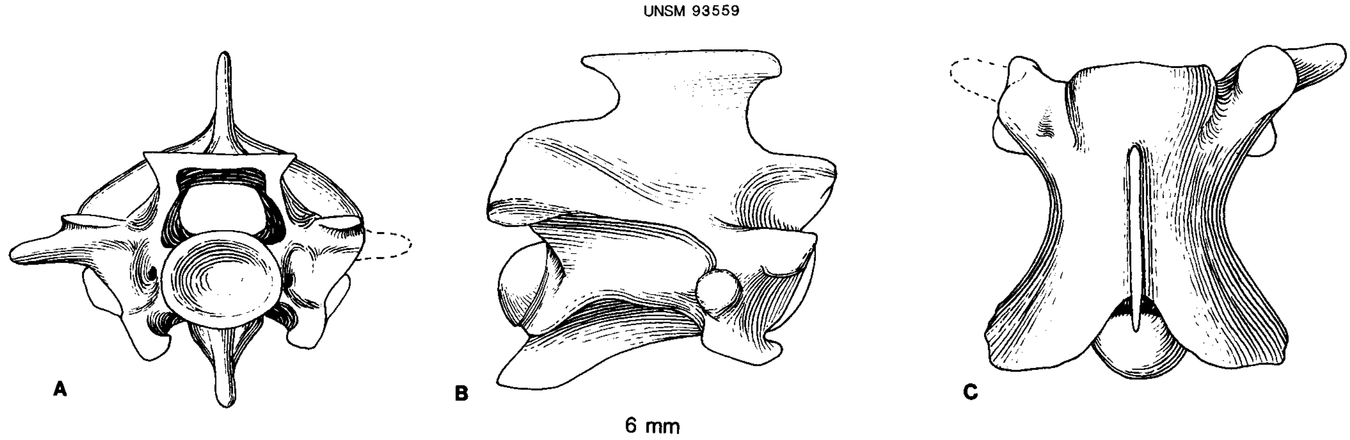


Figure 9. ***Thamnophis*** **vertebra, locality Bn 11, late Barstovian, Banner County, Nebraska.** ***A*** **= anterior view.** ***B*** **= lateral view.** ***C*** **= dorsal view.**

PALEOECOLOGY

As noted in the species accounts above, several of the reptilian taxa present in the Hottell quarries indicate that a mild, probably frost-free, climate prevailed at the time of deposition. Giant tortoises (*Geochelone*) and curl-tail lizards (*Leiocephalus*) have tropical distributions today, and modern patch-nosed snakes (*Salvadora*) also range no closer to Nebraska than southern New Mexico, Arizona, and Texas. The conspicuous lack of boids in the Hottell snake sample, discussed above, seems anomalous in a presumably warm paleoclimate.

Except for unidentified chunks of fossil wood and a few *Celtis* (hackberry) seeds, the Hottell quarries have produced no paleobotanical remains. (Silicified grass anthoecia, "seeds," however, have been collected from above the vertebrate quarry horizons by J. R. Thomasson of Fort Hays State University. Dr. Thomasson (personal communication, 1986) identifies the specimens as *Berriochloa* cf. *communis.*). Speculations concerning the Barstovian vegetation of the area must therefore be based on: 1) consideration of the vertebrate remains themselves; and 2) extrapolation from Barstovian floras in other areas (see Gregory, 1971; Webb, 1977). Most of the lower vertebrates identified in the Hottell samples belong to, or are related to, modern taxa that range through a wide variety of vegetation types. The salamander *Ambystoma minshalli*, however, is a member of the *A. maculatum* group, whose modern members are exclusively forest-dwelling. Its presence suggests that more woodland was present at the time of deposition than in the modern, nearly treeless, high plains of Banner County. A similar conclusion is suggested by the presence of *Scaphiopus wardorum*, an extinct toad whose closest relative, *S. holbrooki*, also lives in the eastern woodlands of North America.

The nearby presence of reasonably extensive forest cover is also strongly suggested by the abundance and diversity in the fauna of mammalian herbivores with brachyodont to mesodont cheekteeth. These presumably browsing forms include *Gomphotherium*, *Zygolophodon*, tapirs, chalicotheres, *Peraceras*, anchitheriine horses, dromomerycids, moschids, leptomerycids, and oreodonts. Ungulates with higher-crowned teeth, probably grazers, are also present (*Protohippus*, *Neohipparion*, *Merycodus*), but their remains do not numerically dominate the available samples as they do those from the Crookston Bridge, Valentine, Railway, and Nenzel quarries, and most other Valentine Formation sites (Frick, 1937).

ACKNOWLEDGMENTS

In addition to the collectors already mentioned above, we thank Gregory W. Brown, who discovered "Immense Journey Quarry" and R. George Corner, who discovered the microfossil concentration at "Corner's Gap." Without their efforts in the field this paper could not have been written. Kenneth Imig and Cindy Loope helped sort the screen-washed samples for microfossils. We also greatly benefited from on-site discussions of the geology of the Hottell Ranch area with James B. Swinehart and Robert M. Hunt, Jr. Brent H. Breithaupt, Michael E. Nelson, and Robert M. Sullivan reviewed the manuscript and provided many valuable suggestions. The University of Nebraska owes an enormous debt to the Andrew Hottell family who for many years allowed access to their property. Our research was supported in part by a grant (INT-8117703) from the National Science Foundation. Mark Marcuson prepared figures 7-9 and Gail Littrell typed the manuscript. We appreciate all of the help.

REFERENCES CITED

Böhme, G., 1982, Biometrische untersuchungen an skelettelmenten von anuran: Wissenschaftliche Zeitschrift der Humboldt-Universitat zu Berlin, v. 31, p. 209-216.

Cassiliano, M., 1980, Stratigraphy and vertebrate paleontology of the Horse Creek-Trail Creek area, Laramie County, Wyoming: Contributions to Geology, University of Wyoming, v. 19, p. 25-68.

Chantell, C. J., 1964, Some Mio-Pliocene hylids from the Valentine Formation of Nebraska: American Midland Naturalist, v. 72, p. 211-225.

______, 1971, Fossil amphibians from the Egelhoff local fauna in North-Central Nebraska: Contributions from the Museum of Paleontology of the University of Michigan, v. 23, p. 239-246.

Conant, R., 1975, A field guide to reptiles and amphibians of eastern and central North America: Houghton Mifflin, Boston, 429 p.

Darton, N. H., 1899, Geology and water resources of Nebraska west of the one hundred and third meridian: U.S. Geological Survey, 19th Annual Report, pt. 4, p. 719-785.

Diffendal, R. F., 1985, The inapplicability of the concept of the "Sidney Gravel" to the Ogallala Group (late Tertiary) in part of southern Banner County, Nebraska: Institute for Tertiary-Quaternary Studies—TER-QUA Symposium Series, v. 1, p. 185-191.

Dowling, H., and Duellman, W. E., 1978. Systematic Herpetology: a synopsis of families and higher categories: Hiss Publications, New York.

Estes, R., and Tihen, J. A., 1964, Lower vertebrates from the Valentine Formation of Nebraska: American Midland Naturalist, v. 72, p. 453-472.

Frick, C., 1937, Horned ruminants of North America: American Museum of Natural History, Bulletin, v. 69, 669 p.

Galbreath, E. C., 1953, A contribution to the Tertiary geology and paleontology of northeastern Colorado: University of Kansas Paleontological Contributions, Vertebrata, art. 4, 120 p.

Green, M., and Holman, J. A., 1977, A late Tertiary stream channel fauna from South Bijou Hill, South Dakota: Journal of Paleontology, v. 51, p. 543-547.

Gregory, J. T., 1971, Speculations on the significance of fossil vertebrates for the antiquity of the Great Plains of North America: Hessisches Landesamt für Bodenforschung Abhandlungen, v. 60, p. 64-72.

Hibbard, C. W., 1960, Pliocene and Pleistocene climates in North America: 62nd Annual Report of the Michigan Academy of Science, Arts, and Letters, p. 5-30.

Holman, J. A., 1964, Fossil snakes from the Valentine Formation of Nebraska: Copeia, 1964, p. 631-637.

Contributions to Geology, University of Wyoming, v. 25, no. 1, p. 55-69, 9 figs., 3 tables, May, 1987

———, 1970, Herpetofauna of the Wood Mountain Formation (upper Miocene) of Saskatchewan: Canadian Journal of Earth Sciences, v. 7, p. 1317-1325.

———, 1973a, Reptiles of the Egelhoff local fauna (upper Miocene) of Nebraska: Contributions of the Museum of Paleontology of the University of Michigan, v. 24, p. 125-134.

———, 1973b, New amphibians and reptiles from the Norden Bridge fauna (upper Miocene) of Nebraska: Michigan Academician, v. 6, p. 149-163.

———, 1976a, Snakes from the Rosebud Formation (middle Miocene) of South Dakota: Herpetologica, v. 32, p. 41-48.

———, 1976b, The herpetofauna of the lower Valentine Formation, north-central Nebraska: Herpetologica, v. 32, p. 262-268.

———, 1977a, Upper Miocene snakes (Reptilia, Serpentes) from southeastern Nebraska: Journal of Herpetology, v. 11, p. 323-335.

———, 1977b, Amphibians and reptiles from the Gulf Coast Miocene of Texas: Herpetologica, v. 33: 391-403.

Holman, J. A., 1978, Herpetofauna of the Bijou Hills local fauna (late Miocene: Barstovian) of South Dakota: Herpetologica, v. 34, p. 253-257.

———, 1979, A review of North American Tertiary Snakes: Publications of the Museum, Michigan State University, Paleontological Series, v. 1, p. 203-260.

———, 1982, New herpetological species and records from the Norden Bridge fauna (Miocene:late Barstovian) of Nebraska: Transactions of the Nebraska Academy of Sciences, v. 10, p. 31-36.

Holman, J. A., and Sullivan, R. M., 1981, A small herpetofauna from the type section of the Valentine Formation (Miocene:Barstovian), Cherry County, Nebraska: Journal of Paleontology, v. 55, p. 138-144.

Hunt, R. M., 1978, Depositional setting of a Miocene mammal assemblage, Sioux County, Nebraska, U.S.A.: Palaeogeography, Palaeoclimatology, Palaeoecology, v. 24, p. 1-52.

Lugn, A. L., 1939, Classification of the Tertiary System in Nebraska: Geological Society of America, Bulletin, v. 50, p. 1245-1276.

Matthew, W. D., 1901, Fossil mammals of the Tertiary of northeastern Colorado: American Museum of Natural History, Memoirs, v. 1, p. 355-447.

———, 1924, Third contribution to the Snake Creek fauna: American Museum of Natural History, Bulletin, v. 50, p. 59-210.

Rage, J.-C., and Holman, J. A., 1984, Des Serpents (Reptilia, Squamata) de type Nord-Américain dans le Miocène Français: evolution parallèle ou dispersion?: Geobios, no. 17, p. 89-104.

Skinner, M. F., and Johnson, F. W., 1984, Tertiary stratigraphy and the Frick collection of fossil vertebrates from north-central Nebraska: American Museum of Natural History, Bulletin, v. 178, p. 215-368.

Skinner, M. F., Skinner, S. M., and Gooris, R. J., 1977, Stratigraphy and biostratigraphy of late Cenozoic deposits in central Sioux County, western Nebraska: American Museum of Natural History, Bulletin, v. 158, p. 263-370.

Smith, C. L., 1962, Some Pliocene fishes from Kansas, Oklahoma, and Nebraska: Copeia, no. 3, p. 505-520.

Smith, F. A., and Souders, V. L., 1975, Groundwater geology of Banner County, Nebraska: Nebraska Geological Survey, Water Supply Paper, no. 39, 96 p.

Stanley, K. O., 1974, Tectonic implications of Tertiary sediment dispersal on the Great Plains east of the Laramie Range: Wyoming Geological Association, 23rd Annual Field Conference, Guidebook, p. 65-70.

Swinehart, J. B., Souders, V. L., DeGraw, H. M. and Diffendal, R. F., 1985, Cenozoic paleogeography of western Nebraska: *In* Flores, R. M., and Kaplan, S. (Eds.) Cenozoic Paleogeography of the West Central United States: Rocky Mountain Section, Society of Economic Paleontologists and Mineralogists, p. 209-229.

Tanner, L. G., 1960, Rhinoceroses of the past: University of Nebraska State Museum, Museum Notes, no. 11, 4 p.

———, 1975, Stratigraphic occurrences of *Teleoceras* with a new Kimballian species from Nebraska: University of Nebraska State Museum, Bulletin, v. 10, p. 23-33.

Tihen, J. A., 1958, Comments on the osteology and phylogeny of ambystomatid salamanders: Bulletin of the Florida State Museum, v. 3, p. 1-50.

Tihen, J. A., and Chantell, C. J., 1963, Urodele remains from the Valentine Formation of Nebraska: Copeia 1963, p. 505-510.

Voorhies, M. R., In press, Vertebrate paleontology of the proposed Norden reservoir area, Brown, Cherry, and Keya Paha counties, Nebraska: University of Nebraska Division of Archeological Research, Technical Report, no. 82-09.

Webb, S. D., 1977, A history of savanna vertebrates in the New World, Part 1, North America: Annual Review of Ecology and Systematics, v. 8, p. 355-380.

Wellstead, C. W., 1982, Lizards from the lower Valentine Formation (Miocene) of northern Nebraska: Journal of Herpetology, v. 16, p. 364-375.

Wellstead, C. W., 1983, *Leiocephalus nebraskensis* nom. nov. pro. *L. septentrionalis* Wellstead, 1982, a junior homonym: Journal of Herpetology, v. 17, p. 408.

Wood, H. E., II, Chaney, R. W., Clark, J., Colbert, E. H., Jepsen, G. L., Reeside, J. B., Jr., and Stock, C., 1941, Nomenclature and correlation of the North American continental Tertiary: Geological Society of America, Bulletin, v. 52, p. 1-48.

MANUSCRIPT RECEIVED: NOVEMBER 8, 1985
REVISED MANUSCRIPT RECEIVED: FEBRUARY 3, 1986
MANUSCRIPT ACCEPTED FEBRUARY 10, 1986