

VERTEBRATE PALEONTOLOGY OF THE LATE MIOCENE (HEMPHILLIAN) WILBUR LOCALITY OF CENTRAL WASHINGTON

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ABSTRACT

The Wilbur Locality, Yakima County, occurs in what has been considered the upper portion of the Ellensburg Formation within central Washington. The Ellensburg Formation is composed principally of volcanoclastic deposits characterized by porphyritic hornblende-dacite clasts interbedded with basalt flows. The Wilbur Locality occurs in a diatomite lens within a fluvially dominated lithostratigraphic unit. The assemblage of vertebrate fossils from the diatomite includes *Pliotaxidea nevadensis*, *Dipoides wilsoni*, a new species of *Pliosaccomys*, *Paronychomys*, and *Castor*, taxa indicative of a Hemphillian age. Reptiles are represented by a colubrid snake and a new pond turtle that exhibits characters that suggest an ancestral position near the emydine and deirochelyine divergence. Additional mammals include *Eucyon davisi*, *Hypolagus* sp. cf. *H. vetus*, *Neotamias* sp. cf. *N. malloryi*, *Neotamias* large sp., *Spermophilus wilsoni*, *Perognathus* sp., *Copemys* sp., and *Megatylopus* sp.. The occurrence of this diverse assemblage in a diatomite suggests a concentration in a ponded paleoenvironment, but no fish or amphibians have yet been recovered. Overall, the Wilbur assemblage accumulated during the Hemphillian North American Land Mammal Age (late Miocene) and represents the only known Hemphillian assemblage from the state of Washington. Other known Ellensburg assemblages are from the older Clarendonian Age. The lithostratigraphic unit containing the Wilbur Locality is dominated by basalt gravels, and with other similar regional Hemphillian units, evinces a major depositional sequence in the Pacific Northwest.

INTRODUCTION

I. C. Russell was the first to mention the Ellensburg sandstone of central Washington in 1893, but subsequent discussions and descriptions have resulted in questions concerning its age and relationships to basalt flows and other lithostratigraphic units. The relatively few diagnostic vertebrate fossils from the differing lithostratigraphic units within the formation have made precise age assignments difficult. Over the last 30 years, the authors have compiled stratigraphically controlled fossil collections from the various Ellensburg units, making refinements possible. One important collection is a vertebrate fossil locality along Maple Way, west of the town of Selah, Washington, discovered in the late 1970s by Mr. Scott Wilbur. He and his parents, George and Yvonne, supported subsequent excavations which have resulted in an important assemblage of vertebrate fossils (Table 1). The Wilbur Locality (SDSM Locality V8910=UWBM Locality C0163) and its contained Wilbur Local Fauna occur in a waterlain tephra and diatomite, a rather unusual source of fossil vertebrates. The diatomite occurs in

a succession of interbedded volcanoclastics and basalt gravels; these have been previously considered as a relatively young phase of the Ellensburg Formation.

Abbreviations: AngE=angle between humeropectoral sulci on entoplastron; A-P=maximum anteroposterior measurement; A-PE=anteroposterior measurement of entoplastron; A-PP=anteroposterior measurement of plastron; A-PV=anteroposterior measurement of anterior dorsal vertebral; CIT=California Institute of Technology, specimens now housed at Los Angeles County Museum; F:AM=Frick Collection, American Museum of Natural History; DV=dorsoventral measurement; H=tooth crown height measurement; NALMA=North American Land Mammal Age; UALP=University of Arizona, Laboratory of Paleontology; UF=University of Florida, Museum of Natural History; UCMP=University of California, Museum of Paleontology; UO=University of Oregon; USNM=United States National Museum; UWBM=University of Washington, Thomas Burke Museum; SDSM=Museum of Geology, South Dakota School of Mines and Technology; Tr=maximum transverse measurement; TrP

ab/fe=transverse measurement of plastron across abdominal-femural suture; TrE=transverse measurement of entoplastron; TrP fe/an=transverse measurement of plastron across femoral-anal suture; TrV=transverse measurement of anterior dorsal vertebral.

TABLE 1. Paleofaunal list from the Wilbur Locality Reptilia.

Wilburemys yakimensis n. gen. et sp.
Colubridae

Mammalia

Eucyon davisi
Pliotaxidea nevadensis
Hypolagus sp. cf. *H. vetus*
Neotamias sp. cf. *N. malloryi*
Neotamias, large sp. indet.
Spermophilus wilsoni
Dipoides wilsoni
Castor, sp. indet.
Pliosacomys prowitteorum n. sp.
Perognathus, sp. indet.
Copemys, sp. indet.
cf. *Antecalomys*, sp. indet.
Paronychomys sp. nr. *P. woodburnei*
Megatylopus, sp. indet.
Camelidae, small sp. indet.
Artiodactyla, fam. indet.

HISTORY OF THE ELLENSBURG FORMATION

Russell (1893) described the detrital strata that occur superjacent to the Columbia River Basalt Group that later became known as the Ellensburg Formation. He considered these strata as correlatives of the "John Day lake" of central Oregon on the basis of fossil leaves (p. 23) and described regions where the strata were well exposed such as outcrops in the White Bluffs area of the Columbia River and exposures in the Wenas and Naches valleys near Yakima. Russell (1893) also noted that correlation of the central Washington strata to those in the John Day Basin was problematical because the John Day beds occur subjacent to the Columbia River basalts in central Oregon, but the strata in central Washington occur suprajacent to the basalts. Moreover, Russell noted that the sedimentary beds immediately below the basalt flows were altered, whereas those above the flows were not. No alteration occurs in the strata in central Washington.

Later, when Russell (1897) described the "John Day" in central Washington, he dropped the section in the Wenas Valley and substituted the statement

"near Ellensburg, in Yakima County." As a result, most researchers consider this area as the type area for what was to become the Ellensburg Formation. Formational designation came in 1900 (p. 127) when Russell utilized the name Ellensburg sandstone in reference to outcrops of 200 feet along the Yakima River between the towns of Dudley and Ellensburg.

However, later revisions have altered Russell's original concepts of formational content, age, and "type area." First, Merriam and Buwalda (1917) proved that the units exposed along the White Bluffs of the Columbia River in eastern Washington mentioned by Russell (1893) were actually much younger than the rocks exposed near Ellensburg in central Washington. They named the White Bluffs strata as the Ringold Formation, based on a much more ferruginous, sandy lithology. Moreover, vertebrate assemblages have been assigned to the Pliocene Blancan NALMA (e.g. Gustafson, 1978; Tedford and Martin, 2001). Removal of the White Bluffs and Russell's prior omission of the Wenas Valley exposures left only the Naches Valley and the "near Ellensburg" as typical exposures for the Ellensburg sandstone. When Russell (1900, p. 127) used the name Ellensburg for exposures along the banks of the Yakima River between Dudley and Ellensburg, he included not only the white, volcanoclastic deposits but also suprajacent brown gravels. As a result, the Ellensburg unit was informally designated as the Ellensburg "white" and the Ellensburg "brown." Much later, Porter (1976) separated the Ellensburg "brown" as the Thorpe Drift, which was renamed as the Thorp Gravel by Waitt (1979), who noted its local nature and restricted Pliocene age (~3.7 Ma, see Waitt, 1979; Reidel et al., 1994) based on tephrochronology.

When Smith (1901, p. 17) termed the Ellensburg strata a formation, he did not designate a type section which was normal practice at this time in history but included one of Russell's (1893) original typical exposures as the best exposure of the Ellensburg Formation. This exposure occurs on the northern side of the Naches River north of the Wilbur Locality and was measured and described by Calkins (in Smith, 1901, p. 17-21). Importantly, Smith (1901) noted the "remarkable absence of basalt pebbles" in this section. Smith (1903a) again stated that the Naches section was the best exposure of the Ellensburg Formation, but also described outcrops near the Normal School (Central Washington State University) in the town of Ellensburg and near Selah Gap north of Yakima. The white volcanoclastic strata near Selah Gap underlie a basalt flow that was later named the Pomona Basalt (Schminke, 1964), and the volcanoclastic strata themselves were named the

Selah Member of the Ellensburg Formation by Mackin (1961). Importantly, Smith (1903b) also noted the occurrence of fossil horses in the Ellensburg Formation.

The terminology, “typical section,” was initially used by Coombs (1941, p. 142-143), who designated the exposure in the Naches Valley as the type section. He justified this section as the type because both Russell and Smith had mentioned the section and because the section was the best exposed and thickest. In his regional geological studies, Schminke (1964) concurred with this type section. Surprisingly, Holmgren (1967, p. 38) disputed this type section designation because he felt that Russell and Smith would have termed these strata in central Washington as the Naches Formation rather than the Ellensburg Formation. Based on this assumption, Holmgren designated the exposures along the Yakima River between Dudley and Ellensburg (NE $\frac{1}{4}$, Section 34, T.19N., R.17E., Kittitas County, WA) as the type section. Most subsequent researchers have supported this section as the type, and we comply with this designation even though strict priority might suggest otherwise. However, this exposure is of limited vertical extent, and we believe that the exposures in the Naches Valley more accurately characterize the Ellensburg lithologies. Therefore, we consider the section described and measured by Calkins (in Smith, 1901, p. 17-21) as a principal reference section. Overall, based upon the original designations, the Ellensburg Formation was considered to be whitish volcanoclastic deposits that overlay the main body of the Columbia River basalts.

Following the descriptive efforts of Russell and Smith, correlations of the Ellensburg Formation were undertaken, including that of Buwalda and Moore (1930, p. 17), who correlated the Ellensburg Formation with the Dalles Formation exposed along the Columbia River in northern Oregon. Their correlation was based on the occurrence of similar horse fossils (in particular *Hipparion condoni*) from both formations. See Martin and Pagnac (2009, p. 198, 204-208) for the nomenclatural history and correlation of this equid species.

Additional efforts in correlation revolved around relationships of the Ellensburg strata with the Columbia River basalts. For example, Waters (1955, p. 672) interpreted the Ellensburg deposits as a marginal sedimentary facies of the Yakima basalt flows of the Columbia River Basalt Group and named a flow interbedded with Ellensburg detrital strata as the Elephant Mountain Basalt, whose type section occurs east of Selah. Later, Schminke (1967) named the volcanoclastic strata occurring between the Pomona and Elephant Mountain basalts as the Rattlesnake Ridge Member of the Ellensburg

Formation. As a result of these designations, the Ellensburg detrital units included at least the Selah, Rattlesnake Ridge, and a supra-Elephant Mountain Basalt unit normally considered the “upper” or “main body” of the Ellensburg Formation (Figure 1). Uniting features of these units is the paucity of significant basalt gravels and their derivation from the Cascade Range to the west (Smith et al., 1988). These units are principally white volcanoclastic sediments characterized by mudstones, lahars, and gravels composed principally of porphyritic dacite.

Waters (1955, p. 674-675) noted unconformities within the Ellensburg Formation in the Yakima area and upper gravels with a high basalt content. He concluded that these upper gravels provided a clear record of contemporaneous folding, deposition, and erosion. Although he considered these unconformities to be minor, he did map one lithostratigraphic remnant along Selah Creek as a separate unit. Foxworthy (1962) noted a separate unit in this area which he described as a cemented basalt gravel and considered as a separate unit from the Ellensburg Formation. Smiley (1963) included the basalt conglomerate within the Ellensburg succession but did note that it was separated from typical Ellensburg deposits by a disconformity. Campbell (1977), Bentley and Campbell (1983), Reidel et al. (1994), and Martin et al. (2005) noted post-Columbia River basalt sediments in south-central Washington which were described or mapped variously as the upper Ellensburg Formation, Ringold Formation, Snipes Mountain conglomerate, or Thorp Gravel. The most reliable date for this basalt-dominated upper Ellensburg gravel in the Yakima Basin is a K-Ar date of 4.72 ± 0.28 Ma from an air-fall tuff in an overlying paleosol (Smith et al., 1989), indicating the gravel could have been deposited during the late Hemphillian (Tedford et al., 2004) and is at least a million years older than the Pliocene Thorp Gravel. In the Toppenish Basin to the east, a K-Ar date of 7.82 ± 0.30 Ma from a tephra interbedded within the basalt gravel indicates an early Hemphillian age. Therefore, the radiometric dates of these basalt-dominated gravels suggest a Hemphillian time of deposition of the uppermost Ellensburg Formation.

The section that contains the Wilbur Locality (Figure 2) is characterized by basalt gravels interbedded with brown volcanoclastics (Figure 3), and a distinct disconformity can be recognized at the base of the section near the bottom of a road cut along Maple Way west of Selah as the road ascends from the Naches Valley. Here, the brown gravels and volcanoclastics exhibit a cut and fill morphology above the whitish volcanoclastics typical of the

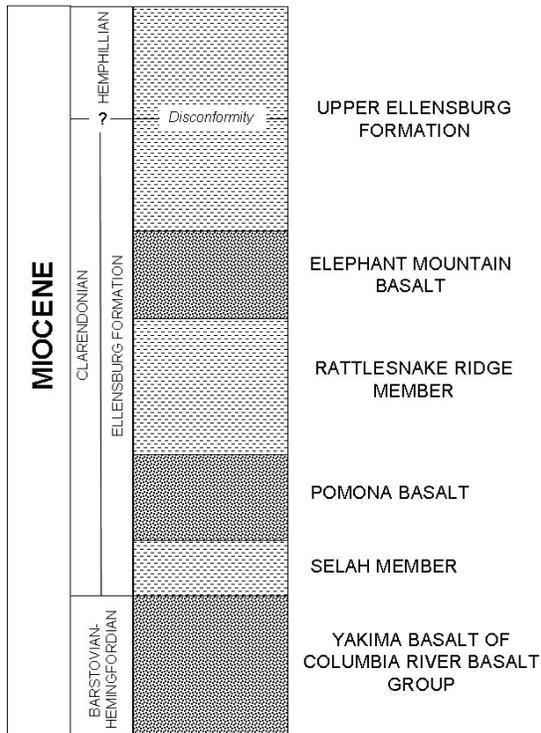


FIGURE 1. Stratigraphy of the Late Miocene deposits of central Washington

Ellensburg Formation. The Pomona Basalt can be observed to the south, so the Rattlesnake Ridge Member of the Ellensburg Formation appears to be the unit into which the basalt gravel unit was incised. Only Quaternary loess appears to overlie the brown basalt-dominated deposits. A dazzling white diatomite lens with reworked tephra occurs about half-way through the section at Maple Way (Figure 3), and within this diatomite, vertebrate fossils were entombed. Moreover, we have preliminarily identified at least 15 species of diatoms from the unit, and a radiometric date of 7.41 ± 0.36 Ma was derived from this diatomite (Smith et al., 1989).

GEOCHRONOLOGY AND PALEONTOLOGICAL HISTORY

The first mention of the age of rocks occurring above the Columbia River basalts was the statement by Chester Stock (in Buwalda and Moore, 1930, p. 17), who suggested an "Upper Miocene or Lower Pliocene stage in the evolution of the Equidae" for horse teeth found in both the Dalles Formation in Oregon and the Ellensburg Formation in central Washington. Currently, this age interval would be considered Barstovian through Clarendonian NALMAs. Although the precise location of the

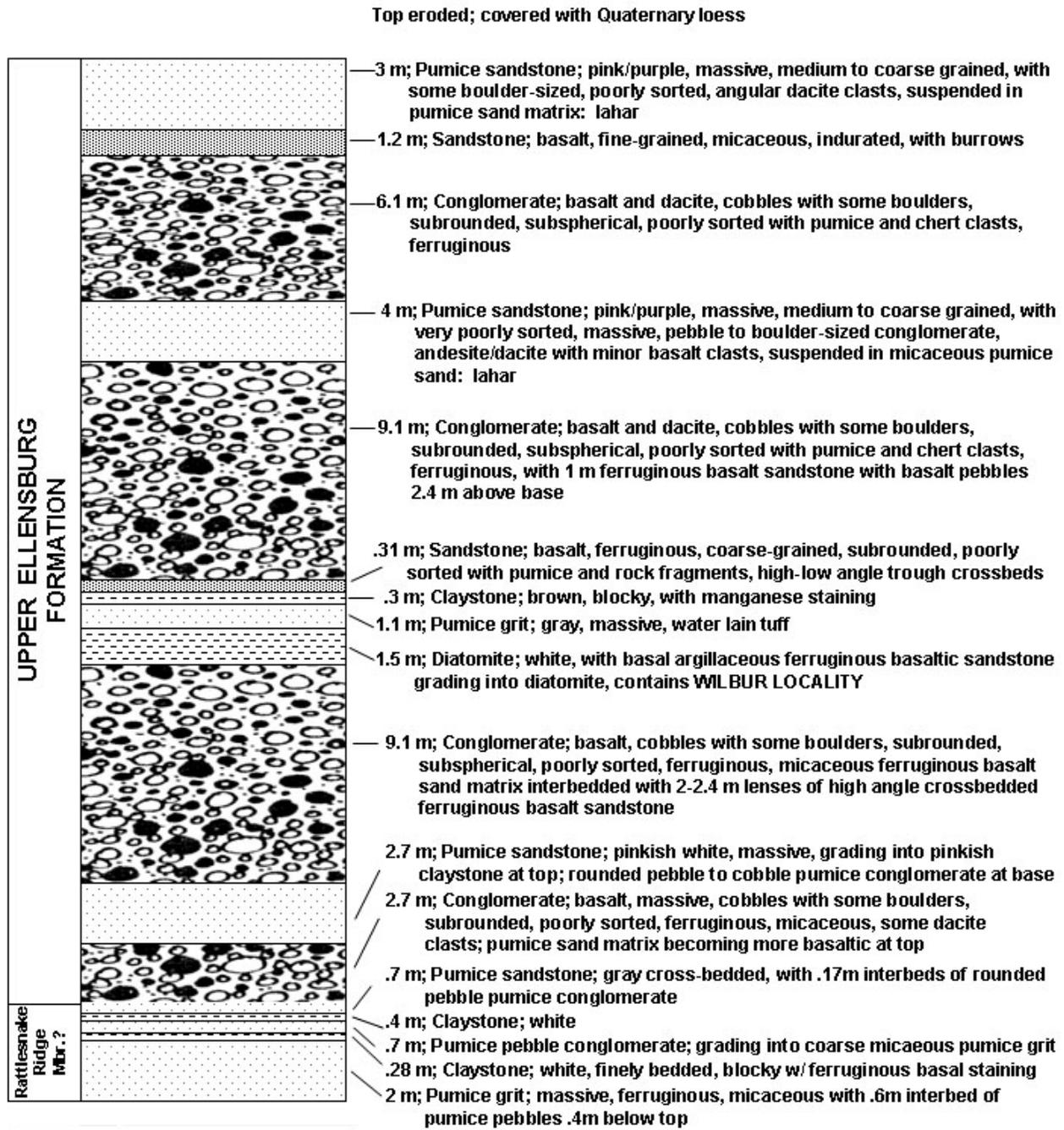
Ellensburg horses described by Merriam (1915) as *Hipparion condoni*, has been questioned, Warren (1941) thought that the specimens probably came from a quarry near Ellensburg where fossil plants had been collected. Smiley (1963) described the fossil plants from the Ellensburg Formation, including the Tyrell Locality, a site in the Rattlesnake Ridge Member, from which a K/Ar date of 10.1 Ma was obtained (Evernden et al., 1964), also indicating a Clarendonian age. Additional specimens of *Hipparion condoni* have been found in relative abundance from Babcock/Foisy Locality in the Rattlesnake Ridge Member of the Ellensburg Formation. On the basis of associated taxa, a late Clarendonian NALMA was assigned to the assemblage from the Babcock/Foisy Locality by Martin and Pagnac (2009).

From another Ellensburg locality, the Granger clay pit, Bryant (1968) described a large mustelid, *Beckia*, now considered *Hoplictis*, whose North American occurrence is during the Clarendonian (Baskin, 1998; Tedford et al., 2004). Bryant also noted the occurrence of a large tortoise, gomphothere, *Hipparion*, a lamine listed as *?Pliauchenia* (now considered a *nomen vanum*, Webb and Meachen, 2004), a medium and large-sized camel, and an antilocaprid. An assemblage of small vertebrate fossils from the Granger clay pit has been collected by Kevin Meeks under the direction of the first author and will be the subject of a later contribution. Preliminary identifications support the Clarendonian age assignment of this unit.

Other Ellensburg occurrences of large mammals have been documented in Foxworthy (1962), Warren (1941), Schminke (1964), and Martin and Tedrow (1988), but none contradicts a Clarendonian NALMA for Ellensburg deposits. The only contradiction to this age was that in an early abstract (Martin, 1979), when a small Hemphillian assemblage was ascribed to the Rattlesnake Ridge Member. However, later investigations indicate that this site, the Wilbur Locality discussed herein, represents a younger lithostratigraphic unit (Figure 1). The Rattlesnake Ridge Member was proven to be late Clarendonian in its type area (Martin and Pagnac, 2009).

TAPHONOMY

The Wilbur Local Fauna was deposited in a 1.5-meter thick white diatomite with reworked tephra and some mudclast breccia. The fossils were found at all levels within the diatomite, although most larger elements occurred closer to the base; conversely, a gopher jaw, cricetid jaw, and rabbit innominate were found within a few centimeters of



Base not exposed



FIGURE 2. Section along Maple Way, including the Wilbur Locality and its location in south-central Washington.

the upper contact. Specimens were generally scattered throughout the diatomite, although a few bone concentrations were noted. Most bones were in hydrologically stable positions; very few were oriented at higher angles. Orientations taken of long elements appear random. Except for the most robust elements such as artiodactyl podials, specimens were found dorsoventrally crushed as the result of postdepositional compaction of the diatomite. Three-dimensional skulls, such as that of the badger, were reduced to two dimensions. Even the turtle shell was flattened. Larger elements are overall better preserved, and dental elements were better fossilized than osteological elements. Smaller bones were often not fossilized or subsequently weathered, leaving the dental elements of a jaw associated without the maxilla or dentary. Elements were microfractured during compaction, even small rodent teeth, making recovery difficult. Typical screen-washing techniques resulted in recovery of larger bones and fragments but few microvertebrates. Although most recovered elements were identifiable, about 25% of specimens were represented by little worn, pebble-sized bone fragments. These occurrences support the contention of a relatively low-energy environment that permitted formation of the diatomite.



FIGURE 3. Photograph of the Wilbur Locality in the white diatomite interbedded with basalt conglomerate.

The occurrence of principally terrestrial vertebrates in a diatomite raises questions about their mode of accumulation. The appearance of turtles and beavers supports the contention of a slow-moving and/or ponded riparian habitat and represent proximal inhabitants. The high silica content of the diatomite was probably furnished by reworked ashfall; enough dateable materials were recovered to produce the radiometric date of (Smith et al., 1989). The terrestrial ungulates, carnivores, and rodents may have sought water to escape the volcanic eruption. However, most skeletons are not

articulated, but some appear associated (e.g. camelids), indicating postmortem fluvial reworking.

SYSTEMATIC PALEONTOLOGY

Class Reptilia Laurenti, 1768
Order Testudines Batsch, 1788
Family Emydidae Lydekker, 1889
Subfamily Emyinae Rafinesque, 1815
Genus *Wilburemys* n. gen.

Generic definition—small to medium-sized turtle with low, broad, unserrated carapace without keel; mesoplastral elements absent; narrow first vertebral scute contained entirely on nuchal; carapace transversely expanded posterior to the bridge; pygal posterior notch moderately grooved; free plastral rim, especially on the plastral forelobe; humero-pectoral sulci crossing the posterior fourth of the entoplastron, which curve posteriorly near the midline to meet in a V-shape; curved posteromedial suture of epiplastral bones; extensive visceral gular scale margin; epiplastral gular bosses (horns) moderately developed; sulcus for the axillary scute on hypoplastral bridge; straight hyo-hypoplastral suture; xiphiplastron greatly expanded posteriorly and laterally, forming a broad, rounded hind lobe; narrow distance between the femoral/anal scute margin and hypo-xiphiplastron suture at midline.

Genotypic species—*Wilburemys yakimensis*

Synonymized species—*Actinemys owyheensis* Brattstrom and Sturn, 1959, considered herein as a *nomen dubium* (see below)

Known range—Hemphillian-Blancan NALMA of Washington, Oregon, and Idaho (see Holman and Fritz, 2001)

Etymology—named for the Wilbur family of Yakima, Washington, in thanks for their contributions in supporting paleontological research in the Pacific Northwest, and *emys*, meaning turtle in Greek.

Differential comparison with emydids characterized by *Actinemys marmorata*, *Clemmys guttata*, *Emys orbicularis*, *Glyptemys insculpta*, *Emydoidea blandingii*, *Terrapene ornata*, *Graptemys barbouri*, *Chrysemys picta*, *Trachemys scripta*, *Pseudemys texana*, *Deirochelys reticularia*, and *Malaclemys terrapin*—*Wilburemys* is a small turtle with unserrated posterior peripherals and carapace not tectiform in cross-section unlike that of *Graptemys* (see Joyce and Bell, 2004, p. 65); narrow first vertebral scute like those of *Clemmys*, *Glyptemys* (Holman and Fritz, 2001, p. 326), and *Chrysemys* but unlike those of *Actinemys*; first vertebral scute contained entirely on nuchal like that of *Actinemys*; carapace transversely expanded

posterior to the bridge like that of *Actinemys* and *Graptemys* and greater than other emydines; posterior pygal notch moderately grooved, unlike the deep notch of *Actinemys* and *Glyptemys*, the slight notch on *Chrysemys*, and the flat pygal of *Clemmys* and *Emydoidea*; medial contact of posterior costals like those of *Terrapene* or *Graptemys* but unlike those of *Actinemys*, *Clemmys*, *Emydoidea*, *Chrysemys*, *Malaclemys*, *Trachemys*, *Deirochelys*, and *Emys* (Joyce and Bell, 2004, p. 66); carapace and plastron connected by osseous bridge like those of *Actinemys*, *Chrysemys*, *Clemmys*, *Deirochelys*, and *Graptemys* unlike those of *Emydoidea*, *Emys*, and *Terrapene* (Joyce and Bell, 2004, p. 68); humero-pectoral sulci on entoplastron curve posterior near the midline to meet in V-shape like those of *Actinemys*, *Terrapene*, and *Clemmys* unlike those of *Chrysemys*, *Emys*, *Emydoidea*, *Graptemys*, *Pseudemys*, *Deirochelys*, *Trachemys*, or *Malaclemys* on which the sulcus lies posterior to the entoplastron (Holman and Fritz, 2001, p. 333; Joyce and Bell, 2004, p. 70); curved posteromedial suture of epiplastral bones like that of *Clemmys* and *Chrysemys* but unlike those of *Actinemys*, *Emydoidea*, *Emys*, or *Glyptemys*; extensive visceral gular scale margin like those of *Clemmys*, *Glyptemys* or *Chrysemys* but unlike those of *Actinemys* or *Emys*; epiplastral gular bosses (horns) moderately developed like those of *Actinemys*, *Chrysemys*, *Glyptemys*, or *Emydoidea* but unlike those of *Clemmys*, *Terrapene*, or *Emys*; sulcus for the axillary scute on hypoplastral bridge like those of *Clemmys*, *Glyptemys*, and *Chrysemys* but unlike the condition of *Actinemys* or *Emydoidea*; straight hyo-hypoplastral suture like those of *Actinemys* and *Glyptemys* but unlike those of *Chrysemys*, *Emys*, *Clemmys*, or *Emydoidea*; xiphiplastron greatly expanded posteriorly and laterally like that of *Chrysemys* but unlike those of *Actinemys*, *Glyptemys*, *Emydoidea*, *Emys*, or *Clemmys*; narrow distance between femoral-anal scute margin and hypo-xiphiplastron suture at midline like those of *Clemmys*, *Emys*, *Emydoidea* and unlike *Chrysemys* in which they nearly coincide, and unlike the wide distance of *Actinemys* and *Glyptemys*; small anal notch of plastron like those of *Emydoidea*, *Emys*, and *Deirochelys*, unlike that of *Terrapene* on which it is absent, or on *Graptemys*, *Clemmys*, *Chrysemys*, *Pseudemys*, or *Trachemys* on which it is more deeply notched (Joyce and Bell, 2004, p. 71).

Wilburemys yakimensis n. sp.

Type Specimen— UWBM 58775, complete carapace and plastron from the Wilbur Locality 1 (SDSM locality V8910=UWBM locality C0163)

Type Locality—Wilbur 1 Locality (SDSM locality V8910=UWBM locality C0163), Yakima County, south-central Washington.

Stratigraphic Source and Age—upper Ellensburg Formation; Hemphillian

Diagnosis—as for genus; see generic definition

Synonymy—*Actinemys owyheensis* Brattstrom and Sturn, 1959, herein considered a *nomen dubium* (see below)

Etymology—named for the county in which the Wilbur Locality occurs and the Latin suffix *ensis*, meaning native or resident in.

Description—UWBM 58775 is a relatively small (AP=15 cm, Tr=12.8 cm), complete, dorso-ventrally crushed turtle shell, with faint dorsal sculpture radiating toward the periphery (Figure 4A). The nuchal element of the carapace is well preserved (Figure 4B) and exhibits a narrow cervical scute that narrows from 4.1 mm posteriorly to only 2.8 mm wide along the anterior margin, and is 10.7 mm anteroposteriorly. The anterior transverse width of the nuchal bone at the carapace edge is 18.2 mm and widens to a maximum transverse width of 38.2 mm. The anteroposterior length of the nuchal bone is 34 mm. The nuchal bone exhibits relatively long anterior scute sulci that trifurcate on the lateral wings of the bone. The posterior end of the nuchal bone is flattened, only slightly concave anteriorly. Vertebral scute 1 lies on the nuchal bone and is relatively long (Table 2), quadrilateral, and widens anteriorly.

The pattern of the neural and costal elements is obscured by crushing, but the peripherals appear long, and the neurals are quadrilateral. At least eight neural bones exist, and eight costal bones and eleven peripheral elements can be observed on each side, but these represent minimum numbers (see interpretation on drawing of Figure 4A). The suprapygal and pygal are wide transversely: 24.8 mm. The posterior notch is moderately well developed on the pygal, deeply grooved on that of *Actinemys* and *Glyptemys inculpta* (see Holman and Fritz, 2001, for nomenclature), but relatively flat on those of *Clemmys guttata* or *Emydoidea*, and slightly notched on that of *Chrysemys*. Although crushed, the carapace of UWBM 58775 appears transversely expanded posterior to the bridge, greater than that exhibited by most emydid taxa, but similar to that of extant *Actinemys*, and to a lesser extent, *Graptemys*.

Ventrally, the shell exhibits an entoplastral bone that is typical for emydines (Fig 4C,D), with the humero-pectoral sulci crossing the posterior fourth of the entoplastron. As the relatively straight sulci approach the midline, they curve posteriorly and meet in a V-shape like those of living *Actinemys marmorata* and *Clemmys guttata*. The angle between the sulci is 25 degrees (Figure 4D), which is

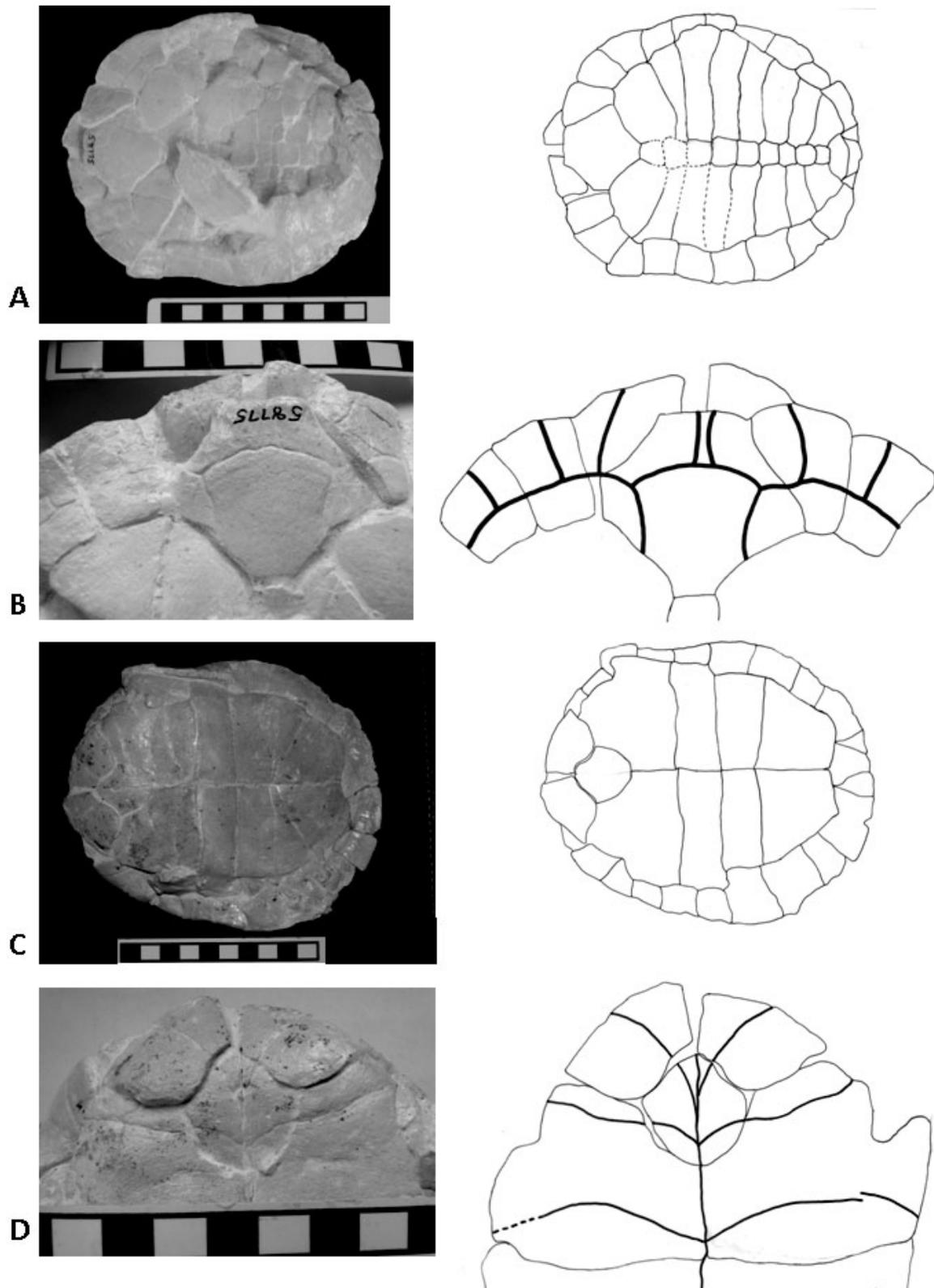


FIGURE 4. *Wilburemys yakimensis*, UWBM 58775. A, carapace (photograph and interpretation). B, anterior carapace. C, plastron (photograph and interpretation). D, anterior plastron. Scale is in centimeters.

TABLE 2. Measurements in cm of UWBM 58775 compared with those of other Emydidae. See introduction for definitions of abbreviations. All Recent specimens repose at UF.

<i>Wilburemys yakimensis</i>		<i>Actinemys marmorata</i>				<i>Clemmys guttata</i>		
	UWBM 58775	UF12055-2	151070	41523	151071	151076	UF67609	109147
A-P	15 (crush)	--	13.3	11.6	13.5	14.5	10.3	10.6
Tr	12.8 (crush)	--	10.2	10.0	10.8	10.6	7.6	8.4
A-PP	13.3	12.7	11.0	11.0	12.2		8.7	10.4
TrP ab/fe	8.7	6.9	7.0	6.5	7.0		5.1	6.2
TrP fe/an	7.1	5.8	5.4	4.9	5.6		4.4	5.0
A-P Vertebral	2.4	2.4	2.8	2.5	3.0	3.1	2.3	2.7
Tr Vertebral	2.5	4.2	3.9	3.1	3.7	3.6	2.2	2.7
A-P Entoplast	2.8	2.6	--	2.1	2.3		1.9	1.7
Tr Entoplast	2.6	3.0	--	2.2	2.2		1.6	1.9
AngEntoplast	25 ⁰	25 ⁰	40 ⁰	33 ⁰	31 ⁰	--	32 ⁰	
<i>Clemmys guttata</i>		<i>Chrysemys picta</i>	<i>Emydoidea blandingii</i>		<i>A. owyheensis</i>			
	UF14242	48440	14249		CIT 5123 5127			
A-P		12.6	31.0					
Tr		9.5	16.0					
A-PP	8.6	11.9	20.6					
TRP ab/fe	5.1	6.2	11.0					
TRP fe/an	4.4	5.0	9.0					
A-P Vertebral		2.6	3.8					
Tr Vertebral		2.6	7.2					
A-P Entoplast	1.6	1.8	3.8		3.4	3.3		
Tr Entoplast	1.5	2.0	3.8		3.6	3.4		
Ang Entoplast		40 ⁰	45 ⁰		28 ⁰	33 ⁰		
<i>Emys orbicularis</i>		<i>Glyptemys insculpta</i>						
	UF67644	63402	UF42554					
A-P		12.9	17.8					
Tr		10.2	13.6					
A-PP		11.8	16.3					
TRP ab/fe		7.2	9.3					
TRP fe/anal		5.7	6.6					
A-P Vertebral		3.4	3.7					
Tr Vertebral		5.0	4.5					
A-P Entoplast	2.9	2.6	3.1					
Tr Entoplast	2.6	2.6	2.9					
Ang Entoplast	30 ⁰	35 ⁰	50 ⁰					

within the range of *Actinemys* (Table 2), although most emydids, including *Actinemys owyheensis* from the Hemphillian of Oregon (Brattstrom and Sturn, 1959), exhibit a relatively larger angle (Table 2; see discussion below). The epiplastral bones of UWBM 58775 are quadrilateral (Figure 4C), expanded laterally, and exhibit a curved posteromedial suture, similar to that of *Clemmys guttata* and specimens of *Chrysemys*, but unlike the flat suture of *Actinemys*, *Emydoidea*, *Emys*, and *Glyptemys*. The dorsal surface of the epiplastral elements is difficult to observe, because the carapace was crushed onto the plastron. Nevertheless, enough of the dorsal

epiplastra are exposed to indicate that the visceral gular scale margin is extensive like those of *Glyptemys insculpta*, *Clemmys guttata*, and *Chrysemys picta*, but unlike the restricted margins of *Actinemys marmorata* or *Emys orbicularis*. Also, the gular bosses (horns) on the epiplastra are moderately developed like those of *Actinemys*, *Chrysemys*, *Glyptemys*, and *Emydoidea*, but unlike the robust bosses of *Clemmys* and *Emys*. The hyoplastral elements are large, articulated at their posterolateral ends with the carapace, and indented anteromedially by the entoplastron. The sulcus for the axillary scute occurs on the right hyoplastral bridge that

articulates to the carapace; the left is crushed. The sulcus occurs on *Clemmys guttata*, *Chrysemys picta*, and species of *Glyptemys* (which have a massive bridge), but not on *Actinemys* or *Emydoidea*. The paired sulci between the pectoral and abdominal scutes are broadly curved anteriorly but converge posteriorly to meet at the midline just anterior to the hyo-hyoplastral suture. The mesoplastral elements are absent. The hypoplastron is relatively simply constructed, consisting of a wide plate that sutures against the carapace anterolaterally. An indistinct groove may represent the inguinal sulcus on the bridge of the right hypoplastron. The transverse anterior and posterior sutures of the hypoplastron are relatively straight, and the sulcus between the abdominal and femoral scutes, which crosses the plastron just posterior to the bridge, is also straight. The xiphiplastron (Figure 4C) is greatly expanded posteriorly and laterally, forming a broad, rounded hind lobe more like that of *Chrysemys picta*, and unlike the narrow, posterolaterally angulate xiphiplastra of *Clemmys guttata*, *Actinemys marmorata*, *Emys orbicularis*, or *Glyptemys insculpta*. The femoral-anal sulci originate at the midline just posterior to the hypo-xiphiplastral suture, flare laterally, and extend to the margin of the plastron. Therefore, the distance between the femoral/anal scute margin and hypo/xiphiplastron suture at the midline is narrow in UWBM 58775, *Clemmys guttata*, *Emys*, and *Emydoidea*, nearly meets in *Chrysemys*, but is wide in *Actinemys* and *Glyptemys*. The posterior margin of the plastron is widely (35 mm) notched (indented), but the notch is proportionally shallow (3.5 mm).

Interestingly, a groove appears across the middle of the right xiphiplastron, extending from the femoral-anal sulcus, subparalleling the sagittal midline, and curving slightly laterally at the posterior margin of the xiphiplastron. This groove is atypical, appears very similar to a sulcus, could be the result of post-mortem alteration; however, such atypical sulci are relatively common among extant testudines (e.g. Zangerl and Johnson, 1957; Sturn and Brattstrom, 1958), and a similar abnormality was noted by Zangerl and Johnson (1957, p. 343).

Overall, the plastron is concave ventromedially, and the feature does not appear to be altogether the result of crushing. This medial concavity suggests that UWBM 58775 represents a male, but crushing cannot be completely discounted as the cause of the concavity.

Discussion—Turtles are relatively poorly known from the Pacific Northwest, particularly from Pleistocene deposits. Turtles such as *Hesperotestudo* (= *Geochelone*) do occur in the late Miocene and Pliocene but become rare in Irvingtonian and

Rancholabrean assemblages. Most known specimens from the Pacific Northwest are very fragmentary and difficult to diagnose; conversely, UWBM 58775 is a nearly complete shell and exhibits an important combination of morphological characters.

UWBM 58775 belongs to the Emydinae, which are characterized by the humeral-pectoral line crossing the base of entoplastron and include *Clemmys*, *Glyptemys*, *Actinemys*, *Emys*, *Emydoidea*, and *Terrapene* versus the Deirochelyinae, which includes the *Chrysemys* complex of *Chrysemys*, *Trachemys*, *Pseudemys*, *Deirochelys*, *Graptemys*, and *Malaclemys*, whose rigid plastron exhibits a humero-pectoral seam crossing posterior to the entoplastron (Ernst et al., 1994; Holman and Fritz, 2001). Recent taxonomic investigations have separated *Actinemys marmorata*, which currently occurs along the Pacific margin, from the more easterly occurring species such as *Clemmys guttata* (Holman and Fritz, 2001; Bickham et al., 2007).

Actinemys is characterized by a number of morphological features including fine striae on the carapace that radiate toward the margin, posteriorly wide carapace, first vertebral scute on the carapace is transversely wide and touches the cervical and marginal set 1 and 2 (Ernst et al., 1994, p. 234), lack of axillary/inguinal scute lines on bridge between carapace and plastron, deep visceral notch on pygal, abbreviated visceral gular scale margins on the epiplastra, gular horns on lateral margin of epiplastra are relatively subdued, the posterior epiplastral suture is not rounded but flat, the suture between the hypoplastron and hypoplastron is transversely straight, and the distance between femoral/anal scute margin and hypoplastron/xiphiplastron suture near the midline is wide.

UWBM 58775 exhibits most of the characteristics of *Actinemys*, but important differences occur: the first vertebral scute is narrow (Figure 4B) contained entirely on the nuchal and touching only marginal set 1 and the cervical, possession of axillary and possibly inguinal scute sulci on the bridge (at least on the right side), extensive visceral gular scale margins, rounded posteromedial edge of the epiplastron, narrow distance between the femoral/anal scute sulcus and the hypo-xiphiplastral suture, and very wide rounded hindlobe of the plastron. The narrow first vertebral scute, presence of axillary and inguinal sulci on the bridge, and expanded visceral gular scale margin are more similar to those characters in species of *Clemmys*, *Glyptemys*, or *Chrysemys*. The narrow Vertebral 1, anteroposteriorly long visceral gular scale margin, and presence of lateral scutes may be plesiomorphic features retained by the latter three

genera and expected in the fossil form. The posteromedially rounded margin of the epiplastron also occurs in *Clemmys* and *Chrysemys* but is transversely flat on *Actinemys*, *Glyptemys*, *Emydoidea*, and *Emys*. However, the polarity of this character is difficult to assess. The narrow distance between the femoral/anal scute margin and hypoxiphial suture occurs on *Clemmys*, *Emys*, and *Emydoidea* and nearly meet in *Chrysemys*, but is wide in *Glyptemys* and *Actinemys*. This character exhibits some variation, but the wide rounded posterior lobe is unlike that of the other taxa whose plastra are relatively long and narrow with angular posterolateral corners of the anal scutes. The visceral groove of the pygal and transversely straight suture between the hyo-hyoplastra are characteristic of *Actinemys* and *Glyptemys*, although the suture may be slightly curved in the latter.

The variability of characters makes taxonomic assignment problematical. The fossil specimen is overall more plesiomorphic than *Actinemys marmorata*, and some synapomorphies are shared with other taxa, particularly *Clemmys guttata*, *Glyptemys insculpta*, and *Chrysemys picta*. However, the wide, rounded plastral hindlobe is unlike that of extant emydines (although *Clemmys* appears wider than *Actinemys*), more like that of *Chrysemys picta*, which does not possess the pygal groove of *Actinemys*. The bridge of *Actinemys* and UWBM 58775 are not nearly as robust as that of *Glyptemys*, whose carapace sculpture is also greater. Therefore, the fossil species lies in a position near the ancestry of the emydine and deirochelyine divergence, but shares most similarity with *Actinemys* and *Clemmys*. UWBM 58775 differs from *Clemmys* in having more subdued gular horns, a straight hyo-hyoplastral suture, and grooved pygal. As a result, the taxon should be considered as a new genus, closely related to *Actinemys marmorata* and *Clemmys guttata*, but also exhibiting characters of other members of the Emydidae.

Other Miocene emydids have been described, but unfortunately, nearly all are based upon single elements, most of which exhibit marked variation. For example, another Hemphillian taxon, *Clemmys hesperia* Hay 1903 was named from the Rattlesnake Formation of Oregon based upon isolated elements. Brattstrom and Sturn (1959) synonymized the species with the extant taxon, *Actinemys marmorata* (Western Pond Turtle), because the elements were not diagnostic. However, in the same article, they named *Clemmys owyheensis*, which was later considered *Actinemys owyheensis* by Holman and Fritz (2001), although Feldman and Parham (2002) proposed on the basis of molecular data that the living species *A. marmorata* should be placed within

the genus *Emys*. Debate has continued on the generic placement of the extant species, and presently we follow Holman and Fritz (2001). Brattstrom and Sturn (1959) based *A. owyheensis* upon isolated elements including two endoplastra and three epiplastra from the Hemphillian Rome Local Fauna in southern Oregon. They (p. 68) illustrated a range of variation of entoplastra, and the entoplastron of UWBM 58775 (Figure 4D) represents another morphotype. On this specimen, the entoplastron is slightly longer anteroposteriorly compared to those of *A. owyheensis* (ratios based on measurements in Table 2: A-PE/A-PP=0.21 on UWBM 58775 vs. 0.21, 0.19, 0.19 on Recent *A. marmorata*; TrE/A-PE=0.92 on UWBM 58775 vs. 0.98, 0.93 on *A. owyheensis* vs. 0.94, 1.14, 1.02 on Recent *A. marmorata*), and the humeral-pectoral sulcus crosses the entoplastron in its distal third and curves distinctly posterior rather than being relatively straight transversely. The entoplastra of the emydine *Glyptemys* illustrated by Holman and Fritz (2001, p. 333) display a great range of length and curvature of the humeral-pectoral sulcus, reflecting great variability. Therefore, these entoplastral features of *A. owyheensis* are not diagnostic. Another diagnostic feature cited by Brattstrom and Sturn (1959) for *A. owyheensis* is a “prominent anterior knob,” which is created by excavation of the lateral sides of the endoplastron. However, indications of this excavation can be observed in some elements of *Actinemys marmorata* illustrated in their publication, as well as on UWBM 58775, although the “knob” is not nearly as well developed on the Washington specimen. Holman and Fritz (2001) illustrated a number of entoplastra of Recent *Glyptemys insculpta* from Michigan that show a complete range from the lack to a well developed “knob.” Therefore, this character also appears exceedingly variable and not diagnostic. The final diagnostic character of Brattstrom and Sturn (1959), the gular-humeral sulci forming an acute angle of 33 degrees or less, can be demonstrated among extant specimens of *Actinemys marmorata* and *Emys orbicularis* (see Table 2), as well as UWBM 58775. The range of variation of entoplastra is wide among emydids, indicating that isolated elements are not suitable for diagnosis. We therefore feel that *Actinemys owyheensis* (and other similar taxa) based upon isolated elements should be considered as *nomen dubia*, because based only on these variable elements, the taxa are not identifiable based on the original diagnoses or from the type material. Once more complete specimens are recovered from their respective type localities and diagnostic features delineated, such species may be resurrected. Another possibility is to consider

UWBM 58775 within the range of variation of *Actinemys owyheensis*. However, this alternative assumes that *A. owyheensis* would share all the other shell characters noted above for UWBM 58775, which appears to require a great leap of faith; therefore, UWBM 58775 is considered as a separate taxon.

Interestingly, the only emydid taxon whose range currently includes the Wilbur Locality is *Chrysemys picta*. *Actinemys marmorata* occurs to the west of the Cascade Mountains. Low turtle diversity in the Pacific Northwest can probably be attributed to the glacial conditions during the Pleistocene, which apparently pushed most turtles southerly. Some taxa have been expanding ranges along major waterways, probably back into preglacial ranges (e.g. species of *Trionyx* and *Graptemys*).

Emydines currently inhabit streams and rivers, and the occurrence of this turtle in a diatomite suggests an aquatic habitat. Moreover, its co-occurrence with castorids indicates a riparian paleoenvironment at the time of deposition at the Wilbur Locality.

Order Serpentes Linnaeus 1785
Family Colubridae Oppel, 1811
Colubridae, gen. et sp. indet.

Referred specimen—UWBM 58777, vertebra; UWBM 58778, 4 poorly preserved vertebrae from the Wilbur Locality 1 (SDSM locality V8910=UWBM locality C0163).

Description—These vertebrae are longer than wide, with small zygosphenes and zygana, small parapophyseal portion of synapophyses, distinct hypapophysis, and long, thin, low neural processes. No epizygapophyseal spines occur. The neural process is very low, slightly indented posteriorly, extends the entire length of the neural arch, and descends to the neural canal. The zygosphenes and zygana are small on the neural arch, which is flattened dorsoventrally and overlies a semicircular neural canal.

Ventrally, the long hypapophysis is preserved on four of the five vertebrae and extends to below the cotyle as a distinct process. The grooves on either side of the hemal keel are very shallow, and no subcentral foramina occur.

Discussion—These vertebrae overall are too fragmentary for more precise taxonomic determination. The low neural processes and hypapophyses occurring on all vertebrae that preserve the ventral margin suggest assignment to the Natricinae (see Holman, 2000).

Class Mammalia Linnaeus, 1758
Order Carnivora Bowditch, 1821
Family Canidae Fischer de Waldheim, 1817
Subfamily Caninae Fischer de Waldheim, 1817
Genus *Eucyon* Tedford and Qiu, 1996
Eucyon davisii (Merriam, 1911)

Referred specimens—UWBM 58817, 2 incisors, 2 canines, left m2; SDSM 15936, 2 incisors, right p3-p4, m1-m2, left p2-p4, m1 from the Wilbur Locality 1 (SDSM locality V8910=UWBM locality C0163).

Description—These two specimens are complementary and might represent a single individual. However, they were found many years apart, and the occlusal wear patterns on the specimens of m2 are slightly different. The range of incisor morphology mirrors that of *Canis latrans*, and the canines are typical with anteromedial and posteromedial carina; the former originates just anterior to the base of the posterior carina, slopes anteriorly to the anteromedially corner, and rises sharply to a point two-thirds the height of the conical, laterally compressed crown.

The lower premolars (Figure 5B) are extremely laterally compressed and elongate anteroposteriorly, forming an effective shearing blade (Table 3). The p2 is a single principal cusp, the p3 also possesses a cuspid at the posterior margin, and the p4 also possesses the posterior cuspid as well as another behind the primary cusp, all aligned anteroposteriorly. This second posterior cusp was cited as a character that unites *Eucyon* with *Canis* (Tedford et al., 2009).

The m1s are high, narrow carnassials (Figure 5A). The paraconid-protoconid blade is nearly anteroposteriorly aligned with a distinct carnassial notch. The metaconid is reduced and situated at the posterolingual base of the large, high protoconid. The talonid is low and composed of a large hypoconid and small entoconid encircling the talonid basin; no transverse crest unites the hypoconid and entoconid. The hypoconid has both anterior and posterior crests, aligned with the paraconid-protoconid blade.

Both m2s are of similar morphology with an anteriorly abbreviated, rudimentary trigonid and shortened talonid. A robust anterior cingulid (Figure 5C) with an expanded anterolingual corner lies at the anterior tooth base below the trigonid and effectively separates the m2 from the carnassial. The paraconid appears as a bulge in the enamel and is greatly reduced in comparison to that of the m1. The small

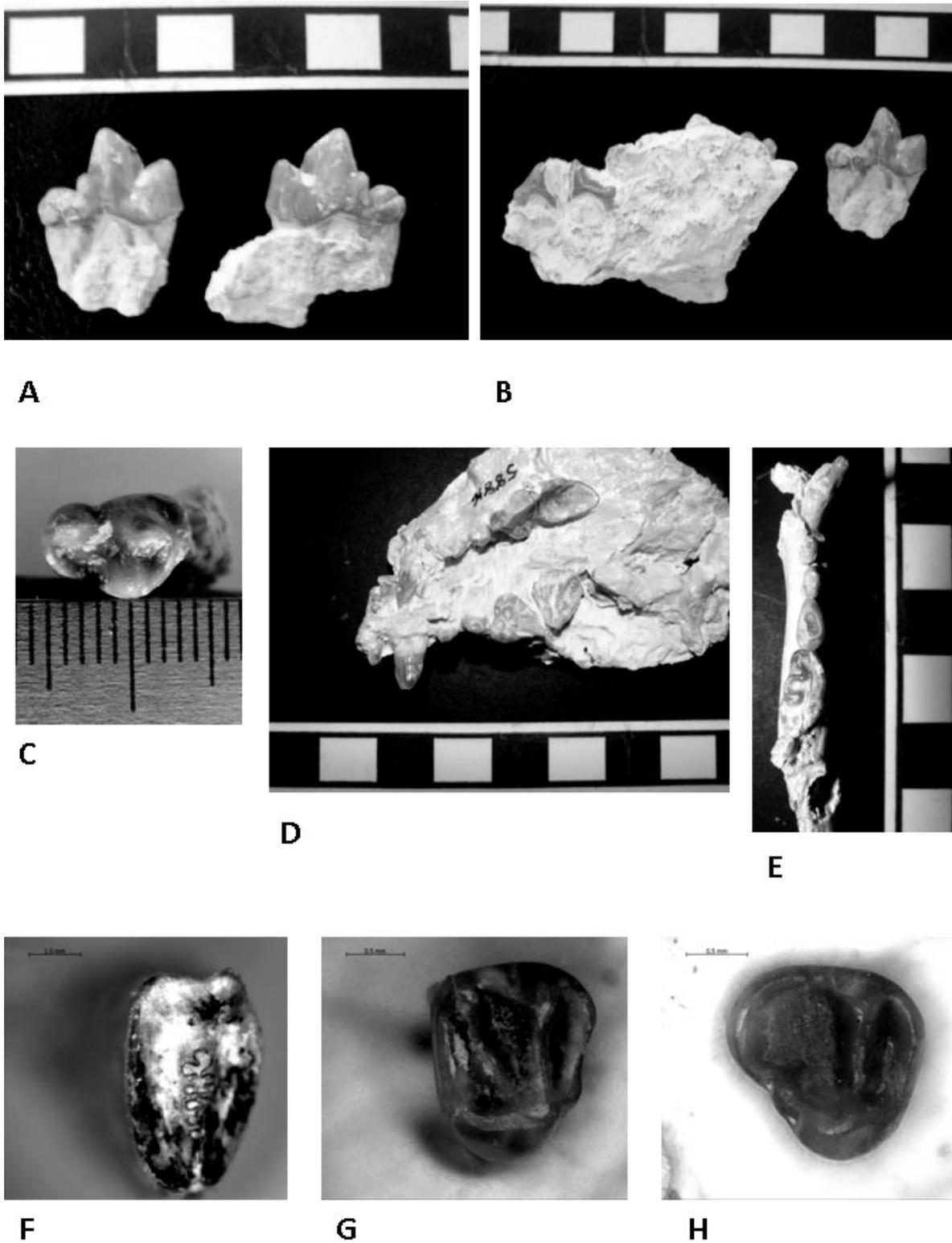


FIGURE 5. *Eucyon davisi*. A-B, SDSM 15936. A, left and right m1 (lingual view). B, left p2-p3, m1. C, UWB 58817, m2. D-E, *Pliotaxidea nevadensis*. UWB 58816. D, cranium. E, right dentary. F, *Hypolagus* sp. cf. *H. vetus*. UWB 58779, upper cheek tooth. G-H, *Neotamias* sp. cf. *N. malloryi*. G, UWB 58788, right M1 or M2. H, UWB 58788, right M3.

paraconid and the anterior arm of the protoconid of m2 encircle a small but distinct, shallow trigonid basin. The metaconid and protoconid are transversely connected by crests emanating toward one another. The result is a transverse ridge exhibiting a distinct medial notch. The talonid is composed of a distinct hypoconid, but the entoconid is reduced, particularly on SDSM 15936. Both cusps are connected by a rounded, robust posterolophid on which no distinct hypoconulid occurs. The appression of the hypoconid and entoconid result in a triangular rather than rectangular tooth outline. The talonid basin is open both lingually and buccally; no cuspid lies between the metaconid and entoconid.

Discussion—The teeth from the Wilbur Locality are typical of those of extant Caninae and are most similar in size and lateral compression to those of *Canis latrans*, indicating similar habits. The delicate construction and lateral compression appear slightly greater than those of many specimens of *Eucyon davisi*, the typical medium-sized canid of the late Miocene (Tedford et al., 2009). These characters are more similar to those of *Canis condoni* described from the McKay Reservoir Locality in northern Oregon (Shotwell, 1956). However, Shotwell (1956) described a separate paraconid on the m2 as characteristic of *Canis condoni* that is not present on the Wilbur specimen (Figure 5C). Moreover, *Canis condoni* has been synonymized with *Eucyon davisi* (Tedford et al., 2009, p. 104), and both possess important canid variations such as the lack of or weak development of a transverse crest between the hypoconid and entoconid and lack or presence of a diminutive hypoconulid posteriorly on m1.

TABLE 3. Dental Measurements in mm of *Eucyon davisi* from the Wilbur Locality

	A-P	Tr
SDSM 15936: left p2	8.8	--
left p3	10.1	--
right p3	11.1	--
left p4	--	5.0
right p4	10.9	--
left m1	18.4	7.3
right m1	18.2	7.5
right m2	8.6	6.3
UWBM 58817: left m2	8.9	6.1

Family Mustelidae Fischer, 1817
 Genus *Pliotaxidea* Hall, 1944
Pliotaxidea nevadensis (Butterworth, 1916)

Referred specimens—UWBM 58816, cranium and right dentary with complete dentition; SDSM 86733, right m1 from the Wilbur Locality 1 (SDSM locality V8910=UWBM locality C0163).

Description—The badger skull is dorsoventrally crushed (Figure 5D); as a result, the cranium is very poorly preserved, but the dentition survived. UWBM 58816 was a very old individual whose dentition exhibits great occlusal wear. Even though the individual was ontogenetically old, the specimen is relatively small (Table 4), much smaller than the living species, *Taxidea taxus*, nearly identical in size to *Pliotaxidea nevadensis* (Butterworth, 1916; Hall, 1944) and *Pliotaxidea garberi* (Wagner, 1976), but larger than *Chamitatus avitus* (Owen, 2006); the latter three known from Hemphillian deposits. A prominent right postorbital process is preserved on USBM 58816, and the crests trending posteriorly from the postorbitals both merge along the midline, unlike the configuration on the type of *P. garberi*, UCMP 52422 (Wagner, 1976), indicating greater maturity of the Washington individual.

The worn dentition further supports the advanced age of UWBM 58816. The premolars are all worn on their tips, and the anterior premolars are not in a successive anteroposterior line but exhibit the typical crowded pattern of badgers. The P4 possesses the pattern characteristic of *Pliotaxidea* and unlike that of *Chamitatus*, which lacks a distinct hypocone. The cingulum lingual to the protocone appears better developed than on the holotype of *P. garberi*. The M1 of UWBM 58816 is likewise worn, and as a result, the concave occlusal surface considered diagnostic of *P. nevadensis* (Wagner, 1976, p. 110) is accentuated. The parastyle appears very high, but its relative height compared to the paracone cannot be positively determined, owing to occlusal wear. Even with wear, the anterior cingulum of M1 does not appear prominent, and the posterior of the tooth is rounded.

The dentary (Figure 5E) associated with the cranium possesses well worn teeth, with many salient cusp morphologies obliterated. However, SDSM 86733 is an unworn m1; unfortunately, the tooth was shattered postmortem by compression of the enclosing diatomite. The trigonid is particularly poorly preserved, but the talonid pattern is recognizable. The entoconid, hypoconid, and a buccal accessory cuspid are arranged in a transverse line, although the entoconid may be slightly posteriorly positioned. The posterior accessory cuspids are incorporated into the posterior cingulid as on the holotype of *P. nevadensis* but unlike the distinct cuspids on the holotype of *P. garberi*.

However, Wagner (1976, p. 113) noted variation of this character, and variation from distinct posterior cuspids to total incorporation into a posterior cingulid has been noted by the first author in a large population from the Hemphillian Ordinance Locality in northern Oregon.

TABLE 4. Dental Measurements in mm of *Pliotaxidea nevadensis* from the Wilbur Locality.

	A-P	Tr
UWBM 58816: right P2	4.1	2.55
left P2	4.2	2.5
right P3	4.9	3.2
left P3	5.2	3.2
right P4	10.0	8.5
left P4	9.9	7.9
right M1	9.1	10.0
left M1	10.4	8.3
right p2	3.6	2.1
right p3	4.5	2.7
right p4	6.7	4.1
right m1	10.8	5.7
right m2	4.0	3.8
SDSM 86733: right m1	11.2	~5.0

Discussion—UWBM 58816 and SDSM 86733 are smaller than living and fossil *Taxidea* and larger than *Chamitataxus avitus* from the late Hemphillian Chamita Formation of New Mexico (Owen, 2006). The Washington specimens also differ from the latter species in possession of a hypocone on P4 and a more triangular M1. The Wilbur specimens do lie within the size range of species of *Pliotaxidea*. Of the two known species, *P. nevadensis* differs from *P. garberi* in possession of a prominent postorbital process, an M1 with the parastyle higher than the paracone, concave occlusal surface, poorly developed anterior cingulum, and rounded posterior apex (Wagner, 1976, p. 110). UWBM 58816 has a distinct postorbital process, and the carnassials and molars display distinctive characters that indicate assignment to *P. nevadensis*, although some dental characters may be equivocal as the result of great occlusal wear. The occlusal surface of the M1 is concave, exhibits a reduced anterior cingulum, and has a rounded posterior apex. Therefore, of described species, the Wilbur specimens most closely resemble those of *P. nevadensis*. However, once the range of variation of the M1 of *Pliotaxidea* is better known, some of these characters may be shown to be variants within a single species.

Order Lagomorpha Brandt, 1885

Family Leporidae Fischer von Waldheim, 1817
 Subfamily Archaeolaginae Dice, 1929
 Genus *Hypolagus* Dice, 1917
Hypolagus vetus (Kellogg, 1910)
Hypolagus sp. cf. *H. vetus*

Referred specimens—UWBM 58785, broken I; UWBM 58779, left upper cheek tooth; UWBM 58780, crushed upper cheek tooth; UWBM 58781, left i; UWBM 58786, deciduous premolar; SDSM 86736, right p3-p4; UWBM 58782, cheek tooth fragments; UWBM 58783, left innominate (acetabulum); UWBM 58784, distal phalanx from the Wilbur 1 Locality (SDSM locality V8910=UWBM locality C0163).

Description—These archaeolagine specimens are in the size range of *Hypolagus vetus* and *H. oregonensis* but smaller than *H. ringoldensis* (See White, 1987). The upper incisor is sharply grooved toward the medial margin as is typical of the lagomorphs. The very hypsodont (H=14.5 mm of UWBM 58779) upper cheek teeth exhibit a typical *Hypolagus* crown pattern (Figure 5F) with a long, greatly crenulated stria that crosses three-fourths of the transverse width. Loph are closely appressed into essentially a single column (A-P=2.7, Tr=4.0 mm).

The lower incisor is smooth-faced and chisel-shaped. UWBM 58786 is a small, bilophid tooth with the lophids connecting medially; however, the anterior tooth face is broken, indicating a third lophid existed as is typical of a deciduous lower premolar of leporids. SDSM 86736, associated p3 and p4, is perhaps the most diagnostic of the Wilbur leporid specimens. Unfortunately, the teeth are relatively poorly preserved, particularly the p3. The anterobuccal corner, lateral margin, and posterolingual corner of the p3 are broken away (Figure 6). However, these enamel splinters do not extend down the entire height of the tooth; the p3 is relatively complete half way down the crown (A-P=3.1; Tr=3.2 mm). The posteroexternal reentrant (PER) is preserved (See White, 1987, for nomenclature), and the thick enamel on the posterior edge of the PER is distinctly sigmoidal. Although the anteroexternal reentrant (AER) is broken from the occlusal surface, its presence can be determined from the groove preserved near the base of the crown. Although poorly preserved, no evidence of an anterior reentrant (AR) occurs on p3. The p4 of SDSM 86736 is typically bilobed (A-P=3.7 mm) with a long anterior lobe (Tr=4.3 mm) and shorter posterior lobe (Tr=3.3 mm). The enamel is straight and thick on the posterior edge of the anterior lobe. The anterior margin of the posterior lobe is also straight and exhibits no crenulations.

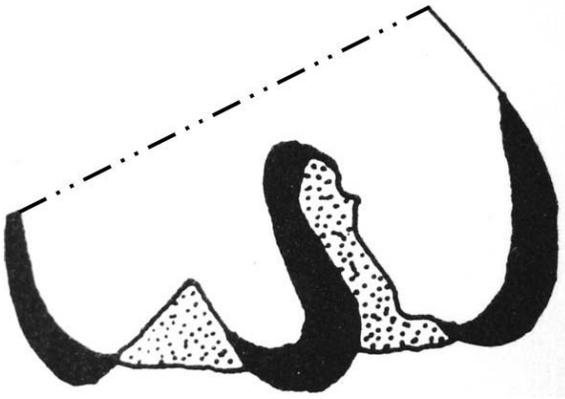


FIGURE 6. *Hypolagus* sp. cf. *H. vetus*, SDSM 86736, right p3.

The innominate is large, consisting only of a broken acetabulum. The roots for all three processes occur, as does the distinct subacetabular groove, characteristic of leporids.

Discussion—Size, hypsodonty, crenulated striae that cross much of the occlusal surface of upper cheekteeth, and morphology of p3 are similar to those of *Hypolagus oregonensis* from the late Hemphillian deposits at McKay Reservoir in northern Oregon (Shotwell, 1956; White, 1987), *Hypolagus ringoldensis* from the Blancan Ringold Formation of eastern Washington (Gustafson, 1978), and *Hypolagus vetus* from Clarendonian and Hemphillian localities throughout the Pacific Northwest (White, 1987). The Wilbur specimens are smaller than those of *H. ringoldensis* more similar in size to those of *H. vetus* or *H. oregonensis*. The p3 possesses a distinct PER and AER, and although somewhat difficult to ascertain, appears to lack an AR. Moreover, the enamel is thick and sigmoidal on the anterior margin of the PER, a feature found more characteristically on the p3 of *H. oregonensis* and *H. vetus*. *H. ringoldensis* is larger and fewer p3 specimens have a sigmoidal anterior margin of the PER. Both *H. ringoldensis* and *H. oregonensis* normally exhibit an anterior reentrant on p3, unlike the condition of *H. vetus*. SDSM 86736 does not appear to possess an anterior reentrant, although this portion of the tooth is not perfectly preserved; therefore, these teeth are only referred to *H. vetus*.

Order Rodentia Bowditch, 1821
 Family Sciuridae Gray, 1821
 Genus *Neotamias* Howell, 1929
Neotamias malloryi Martin, 1998
Neotamias sp. cf. *N. malloryi*

Referred specimens—SDSM 86739, 5 I; UWBM 58787, left I; UWBM 58788, right I, left ?dP4, right M1 or M2, right M3 from the Wilbur 1 Locality (SDSM locality V8910=UWBM locality C0163).

Description—The strongly curved upper incisors exhibit fine longitudinal striae, have thick dentine observable from the lateral aspect, and have a notched occlusal surface at the dentine-enamel interface.

UWBM 58788 represents a single individual. The premolar has no roots, is small compared to the molars (A-P=1.3; Tr=1.4 mm), is more delicately constructed with thinner enamel compared to the molars, and has occlusal wear on the cusp tips. The very large parastyle is well separated from the trigon. The trigon, composed of a large protocone and small subequal paracone and metacone, is obliquely oriented with the protocone anteriorly positioned. These characters suggest a deciduous premolar, particularly the lack of roots that appears to be the result of resorption. A metaconular bulge exists on the metaloph. The protoloph and metaloph merge with the protocone without constriction at the juncture. The posterior cingulum is low, originates from the posterior base of the protocone, trends posteriorly, and curves sharply buccally to end at the base of the metacone.

The upper molar (Figure 5G) retains the large root beneath the protocone, but the buccal roots are broken away. The crown outline (A-P=1.3; Tr=1.6 mm) is subtriangular with a prominent anterior cingulum that parallels the protoloph, extends almost to the buccal margin, and joins the anterior base of the protocone. The protoloph is transversely oriented without a conule, whereas the metaloph trends obliquely and exhibits a metaconule bulge. The posterior cingulum arises from the protocone and angles sharply, forming a somewhat square posterolingual corner. The cingulum extends buccally and fades at the base of the metacone. A short crest extends from the paracone to a distinct mesostyle as is characteristic of *Neotamias malloryi* (Martin, 1998).

The unworn M3 (A-P=1.6; Tr=1.6 mm) has a distinct anterior cingulum (Figure 5H) that mirrors that of the upper molars. The protoloph is straight, and no metaloph exists. The expanded posterior lobe is nearly featureless.

Discussion—These teeth greatly resemble those described originally as *Eutamias malloryi* from the late Hemphillian deposits of northern Oregon (Martin, 1998), particularly in the sharp crest extending from the paracone to the distinct mesostyle on the upper molar. Based upon the distribution of ectoparasites among chipmunks, Jameson (1999)

concluded that those taxa previously considered as species of *Eutamias* (*Neotamias*) should be considered as *Neotamias*. This conclusion was supported by molecular studies of Piaggio and Spicer (2001, p. 345). Because *Eutamias malloryi* is similar to extant species such as *Neotamias minimus* and *Neotamias amoenus*, *Eutamias malloryi* should be considered *Neotamias malloryi*.

The teeth of *Neotamias malloryi* differ from those of *Paratamias tarassus* from early Hemphillian deposits in Idaho (Tedrow et al., 2001) by lack of enamel crenulations. *Nototamias hulberti* from the early Hemingfordian of Florida (Pratt and Morgan, 1989) and *N. quadratus* (Korth, 1992) from the Arikareean of Nebraska do not possess metaconules or cuspsate mesostyle on upper molars. The chipmunk described by Shotwell (1970) from the Hemphillian Bartlett Mountain assemblage in Oregon has a shorter posterior cingulum on upper molars. The Old World chipmunks lack a mesostyle, or the cuspsule is very small (Martin, 1998). Therefore, the teeth from the Wilbur Locality most closely resemble those of *Neotamias malloryi*, although they appear slightly larger and the conules do not appear quite so robust.

Neotamias, large sp. indet.

Referred specimen—UWBM 58798, left m1 or m2 from the Wilbur 1 Locality (SDSM locality V8910=UWBM locality C0163).

Description—The lower molar, UWBM 58798 (A-P=1.4; Tr=1.7 mm), is slightly larger than those ascribed to *Neotamias malloryi*. In this regard, the molar is more similar to *Neotamias* large species described from the latest Hemphillian McKay Reservoir Locality in northern Oregon (Martin, 1998), but smaller than smaller species of *Spermophilus*, such as *Spermophilus gidleyi* from the Rattlesnake Formation of central Oregon (see Black, 1963). UWBM 58798 has an incomplete trigonid valley; only a metalophid spur is directed buccally from the protoconid. A distinct mesoconid and an anterobuccal groove that cuts obliquely into the talonid basin are similar to those characters of *Neotamias malloryi* and *Neotamias* large species. All the major cusps are high, except the entoconid appears incorporated into the posterolophid; however, this area is fractured, leaving some doubt as to entoconid height.

Discussion.—UWBM 58798 is very similar to the m2 of *Neotamias malloryi* and *Neotamias* large species (Martin, 1998) in crown morphology. However, the tooth is larger than most specimens attributed to the former species and is closer in size to the taxon described from McKay Reservoir.

Genus *Spermophilus* Cuvier, 1825
Spermophilus wilsoni Black, 1963

Referred specimens—UWBM 58789, 58793, I; UWBM 58790, left M1 or M2; UWBM 58791, left M3; UWBM 58792, right i; SDSM 86734, broken i; SDSM 82664, right p4-m2; UWBM 58794, right p4; UWBM 58795, left m1; UWBM 58796, left m3 from Wilbur 1 Locality (SDSM locality V8910=UWBM locality C0163).

Description—The upper incisors are greatly curved with wide dentine and narrow crenulated enamel that curves onto the lateral surface. UWBM 58793 (Tr=1.0; depth=3.0 mm) appears very laterally compressed, although this may in part be the result of postmortem crushing.

The upper molar (A-P=2.5; Tr=3.2 mm) is relatively brachydont and worn (Figure 7A). The anterior cingulum is prominent, arising from the anteromidpoint of the protocone via a short crest that angles buccally to end in a distinct parastyle; the posterior cingulum does not possess a metastyle. A deep valley separates the anterior cingulum from the protoloph, whereas the posterior cingulum is separated by a very shallow valley from the metaloph. The protoloph is a transverse crest that intersects the anterior portion of the protocone, whereas the metaloph angles anteriorly to meet the protocone at its midpoint. The metaloph possesses a distinct metaconule and is constricted before it merges with the protocone. A small but distinct mesostyle lies between the paracone and metacone.

The M3 (A-P=2.5; Tr=2.4 mm) is poorly preserved with the anterobuccal and posterolingual corners broken away. The protoloph is a transverse crest separated from the anterior cingulum by a deep valley. The broad posterior shelf exhibits crenulations in the enamel. Other cusps and cuspsules are missing, but small cuspsules lie in the position of the mesostyle.

UWBM 58792 is a typical sciurid lower incisor with rounded, slightly crenulated enamel curving onto the lateral surface. The width of the incisor is 1.3 mm and depth equals 1.9 mm.

The premolar (UWBM 58794: A-P=2.8; Tr=2.5 mm; SDSM 82664: A-P=2.2; Tr=2.1 mm) has the anterior portion of the tooth laterally compressed (Figure 7B), so the protoconid and metaconid are closely appressed, resulting from the lingual displacement of the protoconid. On SDSM 82664 (Figure 7D), a small anteroconid occurs at the base of the protoconid. The hypoconid dominates the posterolingual corner, whereas the entoconid is incorporated into the crest that curves from the hypoconid to the metaconid. The entoconid is more

distinct on SDSM 82664. No mesoconid appears, and only two roots are observable beneath the anterior and posterior portions of the tooth.

The m1 (UWBM 58795: A-P=2.6; Tr=2.7 mm; SDSM 82664: A-P=2.5; Tr=3.0 mm) is nearly square, has a complete trigonid valley with both an anterior cingulid and complete metalophid. No mesoconid exists, and the hypoconid is large and separated from the main body of the tooth. The entoconid is distinct and well separated from the metaconid; the talonid basin is slightly rugose. The m2 (SDSM 82664: A-P=3.2 mm) has the hypoconid broken away but is otherwise similar to the m1, although an incipient mesoconid appears on the ectolophid of the m2.

The m3 (A-P=2.75; Tr=2.85 mm) has an incomplete trigonid valley (Figure 7C); the metalophid is a short spur from the protoconid that fades into the trigonid basin. The hypoconid is robust, but the entoconid is incorporated into the posterolophid. The mesoconid area is broken.

Discussion—The spermophiline teeth from the Wilbur Locality (Figure 7A-D) are of the same relative size as those of *Spermophilus wilsoni* and *S. shotwelli* but slightly larger than those of *S. mckayensis* previously described from the Pacific Northwest. The cheek teeth are rhomboidal, brachydont, and the m1-m2 do not appear compressed anteroposteriorly like those of *S. shotwelli* and *S. mckayensis* (Black, 1963). In most respects, the morphology of these specimens closely follows the description of *S. wilsoni*. Only the relatively complete metalophid and incipient mesoconid on the m2 of SDSM 82644 might be contradictory, but these features exhibit variation in samples of *S. wilsoni* from the McKay Reservoir Locality of northern Oregon.

Spermophilus wilsoni was previously described from the Ellensburg Formation by Black (1963, p. 208), based on a nearly complete cranium (UCMP 55611), but the precise locality of this specimen is unknown. Nevertheless, the black preservation of this cranium has been observed in other Ellensburg specimens. Therefore, *S. wilsoni* ranges from Clarendonian to late Hemphillian strata, so the occurrence at the Wilbur Locality could be expected. These specimens represent a brachydont spermophiline that had not attained the hypsodonty of the late Hemphillian taxon, *Spermophilus* (*Spermophilus*) *mckayensis* (Shotwell, 1956; Black, 1963).

Family Castoridae Gray, 1821
Genus *Dipoides* Schlosser, 1902
Dipoides wilsoni Hibbard, 1949

Referred specimens—UWBM 58801, left i; SDSM 86737, right i fragment; UWBM 58802, right p4 from the Wilbur Locality 1 (SDSM locality V8910=UWBM locality C0163).

Description—The lower incisor, UWBM 58801, is small (Tr=4.0 mm), consists of half of the incisor with dentine preserved, and exhibits faint enamel crenulations on the incisor face as is typical for species of *Dipoides* (Martin, 2008a).

The p4 (Figure 7G, H) is relatively small (A-P=5.2; Tr=3.8; H=14 mm), very hypsodont, delicately constructed, and with no evidence of root formation. The S-pattern characteristic of species of *Dipoides* is apparent. A slight indentation occurs in the position of a paraflexid, but is indistinct and occurs only as a faint groove extending only half way down the tooth crown. The mesoflexid and hypoflexid have relatively medially expanded borders and the terminations are blunted, not pointed. The medial lophid is anteroposteriorly expanded. The enamel surface of the premolar exhibits the slightly crenulated surface observed on the lower incisor.

Discussion—The lower incisor is typical of the morphology of *Dipoides*, and this specimen is relatively small, in the size range of *Dipoides wilsoni* rather than *D. smithi* from the latest Hemphillian McKay Reservoir (Shotwell 1955; Martin, 2008a). The p4, especially the relatively small transverse width, is much closer to small species of *Dipoides* than to medium or large species. In this regard, the specimen is more similar to the late Clarendonian species, *D. tanneri*, and Hemphillian species such as *D. wilsoni*, *D. vallicula*, or *D. williamsi*, than to *D. stirtoni* or *D. smithi*, or to the very large Blancan species, *D. intermedius* or *D. rexroadensis*. UWBM 58802 can be distinguished from *D. tanneri* because of the distinct parastrid on the late Clarendonian taxon from Nebraska (Korth, 1998) and from *D. vallicula* from the Hemphillian Little Valley assemblage of southeastern Oregon (Shotwell, 1970) by its blunt flexid terminations rather than broadly expanded and an anteroposteriorly elongated medial lophid rather than one that is short and broad. Although *D. williamsi* from the Hemphillian of Arizona (Stirton, 1936; Baskin, 1979) is known by relatively few specimens, the species appears to be characterized by a very transversely short posterior lophid on p4, shorter than that of UWBM 58802 (3.5 vs. 3.8 mm). UWBM 58802 resembles *D. wilsoni* from the Hemphillian Saw Rock Canyon, Kansas (Hibbard, 1949), and from earlier occurring localities at Arlington and Ordance in northern Oregon (Martin, 2008a) in having medially expanded lophids and relatively blunt flexid terminations.

Genus *Castor* Linnaeus, 1758

Castor, sp. indet.

Referred specimen—UWBM 58800, left upper incisor fragment from the Wilbur 1 Locality (SDSM locality V8910=UWBM locality C0163).

Description—The upper incisor fragment, UWBM 58800, is wide (~5 mm) and consists of the enamel from the tip of the tooth. The enamel is characterized by transverse crenulated laminae that appear angled distally, identical to those of extant *Castor canadensis*. The incisor face is faintly rugose, but the laminae have little effect on the morphology of the face.

Discussion—UWBM 58800 is too large to be assigned to the species of *Dipoides* described above. The crenulated laminae are similar to those of fossil and extant species of *Castor*. However, the single specimen is not diagnostic at a specific level.

Castor was thought to first appear in North America during the late Hemphillian in northern Oregon (Shotwell, 1956; Martin, 2008a) and Nebraska (Voorhies, 1990). However, one specimen of questionable source was described from early Hemphillian deposits at Rome, Oregon (Wilson, 1937; Martin, 2008a), and two molars have recently been described (Samuels and Zancanella, 2011) from below the Rattlesnake Ashfall Tuff in the type area of the Rattlesnake Formation in central Oregon. These sediments were likewise deposited during the early Hemphillian (Martin, 1983, 2008a). These three occurrences indicate that the first appearance of *Castor* can now be extended back to the early Hemphillian. One of us (Martin, 2008a, p. 183) mentioned that *Castor* might appear earlier than the late Hemphillian based on the specimen described by Wilson (1937), and this occurrence at the Wilbur Locality and those from the Rattlesnake Formation confirm that suspicion. Consequently, the *Castor-Parapliosacomys* Concurrent Range Zone (Martin, 2008a, p. 185) is hereby renamed the *Parapliosacomys* Range Biozone, and except for the occurrence of *Castor*, its characterization remains the same (Martin, 2008a, p. 183-185) as a defining biostratigraphic biozone in the Pacific Northwest.

Family Heteromyidae Gray, 1868

Genus *Perognathus* Maximilian, 1839

Perognathus, sp. indet.

Referred specimens—UWBM 58803, 1; UWBM 58804, 3 I from the Wilbur 1 Locality (SDSM locality V8910=UWBM locality C0163).

Description—These incisors are grooved (a characteristic of *Perognathus*), very small (Tr=0.7-0.75 mm), but not so curved as those of

Reithrodontomys, which also has grooved incisors. They compare well with those of *P. stevei* from Hemphillian deposits in northern Oregon (Martin, 1984), but specific assignment cannot be made from incisors.

Family Geomyidae Bonaparte, 1845

Subfamily Geomyinae Baird, 1857

Genus *Pliosacomys* Wilson, 1936

Pliosacomys prowitteorum, n. sp.

Type Specimen—UWBM 58806, right dentary with i, p4-m2 and associated poorly preserved postcranial elements

Type Locality—Wilbur 1 Locality (SDSM locality V8910=UWBM locality C0163), Yakima County, south-central Washington.

Stratigraphic Source and Age—upper Ellensburg Formation; Hemphillian

Referred Specimen—UWBM 58805, upper incisor

Diagnosis—relatively small geomyine; dentary smooth-sided with distinct posterior incisor capsule, relatively smooth posteroventral symphysis, and posteroventral symphysis terminating anterior to p4; cheekteeth relatively high-crowned; m1-m2 monolophid at early wear stage with lingual margins more pointed than buccal margins; dentine tracts very rudimentary and do not extend 2 mm; occlusal enamel thickness relatively consistent.

Etymology—named in reference to its less derived morphology in comparison to that of *Parapliosacomys witteorum* Martin (2008a,b)

Description—The upper incisor, UWBM 58805, is chisel-shaped with a smooth enamel surface (Tr=1.1 mm), and the lower incisor, UWBM 58806, is similar (Tr=1.1 mm) but not so curved.

The dentary is relatively small (A-P=10.6; alveolar row=5.7; depth below p4=4.4 mm) and greatly resembles that of *Pliosacomys dubius* (Wilson, 1936). The ventral margin of the dentary is relatively smooth and not greatly angled like that of species of *Parapliosacomys* or *Thomomys*. The posterior margin of the symphyseal scar terminates at a point below and anterior to the p4, whereas that of *Parapliosacomys* and *Thomomys* occurs below and posterior to the p4, respectively (Martin, 2008a, p. 168). The external face of the dentary appears smooth, unlike the lateral rugosities indicating molding around the roots of the high-crowned cheek teeth roots of *Parapliosacomys* or *Thomomys*. Therefore, although the new taxon appears to possess relatively high-crowned cheek teeth, they are not as hypsodont as those of *Parapliosacomys* or *Thomomys* (Martin, 2008a).

UWBM 58806 possesses a moderately worn, relatively high-crowned, well-preserved dentition (Figure 7E, F) that is smaller than that of *Pliosacomys higginsensis* (Dalquest and Patrick, 1989) and in the size range of that of *Pliosacomys dubius* (Wilson, 1936). The p4 retains a trefoil pattern but the molars are worn to a single pillar with pointed lingual margins. Enamel surrounds the outside margins of the cheek teeth and remains of relatively consistent thickness, although slight thickening may occur on the posterior enamel margin of each tooth. The p4 (A-P=1.4; Tr=1.4 mm) is typically geomyine with a distinct trefoil pattern on the anterior lophid. The hypolophid is worn to a transverse crest that mirrors the structure of the lower molars. A very short internal dentine tract occurs at the lingual base of the hypolophid, but its development is not as great as that of species of *Parapliosacomys* (Shotwell, 1967; Martin, 2008a) and is more similar to some specimens of *Pliosacomys* (Wilson, 1936). The lower molars are worn to a monolophid stage (m1=A-P=0.75; Tr=1.6 mm; m2-A-P=0.70; Tr=1.5 mm), and no evidence of the transverse valleys characteristic of *Pliosacomys dubius* and *Pliosacomys higginsensis* or dentine tracts characteristic of species of *Parapliosacomys* are observable. Both internal and external margins of m1-m2 are squared, but the internal margin is more pointed, indicating a tendency toward the condition of extant *Thomomys*.

Discussion—These teeth are typically geomyine and are related to the *Thomomys* clade based upon ungrooved incisors, trefoil pattern on p4, and enamel on all tooth margins. The relatively low-crowned teeth and lack of dentine tracts indicates a taxon similar to *Pliosacomys* and less derived than *Parapliosacomys* that is very hypsodont with long dentine tracts (Martin, 2008a). However, the monolophid nature of the molars at this wear stage suggests the Washington taxon is more derived than either *Pliosacomys dubius* (Wilson, 1936) from the early Hemphillian of southeastern Oregon or *Pliosacomys magnus* (Kellogg, 1910) from the early Hemphillian of Nevada. *Pliosacomys prowitteorum* appears transitional between *Pliosacomys dubius* and *Parapliosacomys witteorum*. *Pliosacomys dubius* exhibits low-crowned, bilophid m1-m2 with only incipient dentinal tracts; *Parapliosacomys* displays high-crowned, monolophid m1-m2 with dentinal tracts extending at least 2 mm (Martin, 2008a). *Pliosacomys prowitteorum* has attained the monolophid, relatively high-crowned m1-m2, but the dentinal tracts are in the early stage of development. The dentary likewise exhibits a plesiomorphic state with rounded ventral symphyseal margin, short symphysis, and lack of external rugosities for very

hypsodont cheek teeth. Therefore, a morphological evolutionary succession may be postulated during the Hemphillian NALMA from *Pliosacomys dubius* through *Pliosacomys prowitteorum* to *Parapliosacomys witteorum* through *Parapliosacomys oregonensis* to species of *Thomomys*.

Family Cricetidae Fischer von Waldheim, 1817

Genus *Copemys* Wood, 1936

Copemys, sp. indet.

Referred specimens—SDSM 86732, 2 left I; UWBM 58808, right I; SDSM 86741, 9 i; UWBM 58807, left dentary with i, m1-m3; SDSM 86742, right I, broken m1, m2-m3; SDSM 82665, right m1 (broken); SDSM 82666, left M2 from the Wilbur 1 Locality (SDSM locality V8910=UWBM locality C0163).

Description—The upper incisor is typically cricetine, being smooth-faced, greatly curved, and with thin enamel capping dorsoventrally thick dentine.

The M2 is well preserved except for the anterobuccal corner, which is broken off. The lingual portion of the anterior cingulum is well separated from the protoloph (=paraloph), which connects to the anterolingual portion of the protocone. The well-formed mure possesses a distinct mesoloph that ends in a mesostyle. Anteriorly, the mure branches into an anteroposterior crest that connects with the protoloph and an oblique crest that connects with the protocone. Therefore, with wear, a fossette would form buccal to the protocone as is observed on UWBM 57785 an M2 described as *Copemys* from the Hemphillian Ordnance Locality in northern Oregon (Martin, 2008a). In fact, the Washington specimen agrees in all aspects of its morphology with the Oregon specimen, including size.

TABLE 5. Dental measurements in mm of *Copemys*, sp. indet.

	Tooth	A-P	Tr
UWBM 58807	m1	1.65	1.2
	m2	1.55	1.1
	m3	1.25	1.05
SDSM 82665	m1	--	1.1
SDSM 86742	m2	1.35	.94
SDSM 86742	m3	1.22	.88
SDSM 82666	M2	--	1.2

The dentary of UWBM 58807 is poorly preserved (Figure 7J), and the molars are

fragmented. Nevertheless, the dental pattern is clear, as is that of SDSM 82665, an m1, which is well preserved (Figure 7I) except the anteroconid is broken away. SDSM 86742 is very poorly preserved; the dentary was decomposed, and the incisor and molars were found associated. The m1 of this specimen was broken along the anteroposterior midline, and the anteroconid was broken away. The m2-m3 are well preserved and are similar to those of UWBM 58807.

The incisor of UWBM 58807 is long, thin, gently curved, and smooth-faced. The m1 (Figure 7J) anteroconid appears incipiently bicuspid with a faint anterior groove. The cuspule anterior to the metaconid is prominent, but that just buccal to the midline is much smaller. An anterior cingulid originates from this enamel bulge and swings posterobuccally to fade at the base of the protoconid. The metaconid and protoconid are connected at their anterior ends by a metalophid that sends a short spur anteriorly to merge with the smaller anteroconid cuspule. The entoconid and hypoconid are likewise connected at their anterior ends via a short hypolophid that sends a medial crest to form a distinct murid. A prominent mesolophid trends from the murid to the lingual margin of the molar and ends in a very distinct mesostylid. A large posterior cingulid originates from the hypoconid and swings posteriorly to the lingual margin of the tooth.

The m2 (Figure 7J) of UWBM 58807 is broken through the metaconid and mesolophid area, so the condition of the latter is unknown, but the m2 of SDSM 86742 is complete. The anterior portion of the rectangular second molar is represented by a long cingulid well separated from the protoconid, but appears more closely appressed lingually near the metaconid. A distinct murid can be observed, so an oblique arrangement of the protoconid-entoconid was not possible. The posterior of the m2 mirrors that of the m1, although the posterior cingulid is slightly shorter and appears more angulate.

Specimens of m3 have an occlusal outline of an elongate triangle with a rounded posterior margin. The protoconid is the same size as the metaconid but with a slightly smaller hypoconid. The entoconid appears absent or is replaced with a mesolophid-like crest. Overall, the m3 is relatively unreduced (Table 5). The m3 of UWBM 58807 is worn (Figure 7J), and the buccal arm of the anterior cingulid is long and well separated from the protoconid, similar to that of the m2. A distinct murid is decorated with a prominent mesolophid that ends in a metastylid as in the m1. The murid of UWBM 58807 angles dorsolingually to its intersection with the mesolophid, and the anterior arm of the hypoconid joins the intersection with the mesolophid to form an

angulate murid. The posterior portion of the m3 of UWBM 58807 exhibits greater occlusal wear so only a fossettoid occurs. The m3 of SDSM 86742 is even more worn so only the fossettoid is preserved posteriorly, formed lingual to the hypoconid and anterior to the posterior cingulid.

Discussion—These brachydont cricetids represent a less derived taxon than *Peromyscus*, which exhibits an oblique arrangement of successive lingual and labial cusp(id)s (Lindsay, 1972). The Wilbur specimens exhibit distinct mure(id)s and distinct mesoloph(id)s; the m1 of SDSM 82665 and UWBM 58807 are similar to, but slightly larger than UWBM 57786 and UWBM 57758 from Hemphillian deposits of northern Oregon that have been assigned to *Copemys* (Martin, 2008a). However, the m1 of UWBM 58807 differs in an incipiently bicuspid anteroconid similar to that of *Abelmoschomys* from the latest Clarendonian Love Bone Bed of Florida (Baskin, 1986), but the widely separated major cusps, very well formed mesoloph(id)s, and long mure(id)s of the Washington molars indicate a slightly more plesiomorphic condition. These character states may fall into the range of variation of *Abelmoschomys*, a brachydont cricetid, but a more conservative assignment to *Copemys* is followed herein until more specimens become available and the ranges of variation are better understood.

Genus *Antecalomys* Korth, 1998

cf. *Antecalomys*, sp. indet.

Referred specimen—SDSM 86740, left m1 from the Wilbur 1 Locality (SDSM locality V8910=UWBM locality C0163).

Description—The lower first molar is small (A-P=1.48; Tr=1.1 mm) and very similar to those described above as *Copemys*; however, SDSM 86740 has a single anteroconid on a long anterior cingulid, possesses no mesolophid, and the protoconid and entoconid are nearly directly connected.

Discussion—The lack of a mesolophid and direct connection of the protoconid and entoconid of SDSM 86740 is unlike typical m1s of *Copemys* or *Abelmoschomys* and more similar to species of *Antecalomys*. *Antecalomys* was described as possessing an asymmetrical to weakly divided anteroconid on m1 (Korth, 1998). SDSM 86740 exhibits an asymmetrical anteroconid which is similar to species of *Antecalomys*; for example, UALP 5920 of *A. vasquezi* described from the Hemphillian Redington Local Fauna (Jacobs, 1977), UO 26920 of *A. valensis* from the Hemphillian Little Valley Locality of Oregon, or UNSM 101552 of *A. phthanus* from the late Clarendonian Ash Hollow Formation of Nebraska (Korth, 1998).

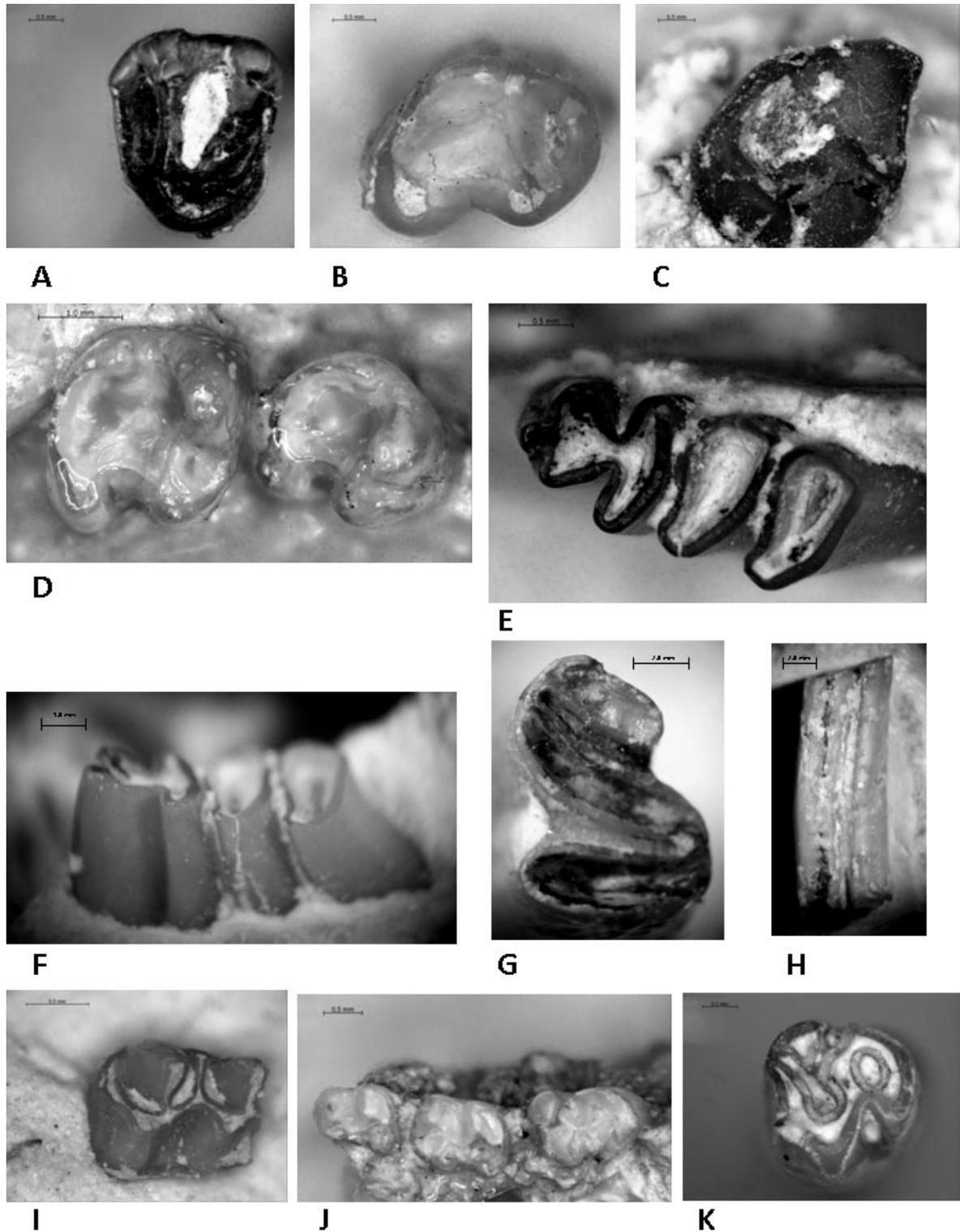


FIGURE 7. A-D, *Spermophilus wilsoni*. A, UWBM 58790, left M1 or M2. B, UWBM 58794, right p4. C, UWBM 58796, left m3. D, SDSM 82664, right p4-m1. E-F, *Pliosacomys prowitteorum* n. sp. E-F, UWBM 58806, holotype, right dentary with p4-m2. E, occlusal view. F, lateral view. G-H, *Dipoides wilsoni*, UWBM 58802, right p4. G, occlusal view. H, lateral view. I-J, *Copemys*, sp. indet. I, SDSM 82665, right m1. J, UWBM 58807, left dentary with m1-m3. K, *Paronychomys*, sp. indet., UWBM 58809, left M3.

Interestingly, this tooth was found in a small (15x10x5 cm) block of matrix with SDSM 86732, 86741, and 86742 described above as *Copemys* sp. indet.; therefore, the possibility exists that this specimen represents an extreme variant of that taxon. Such wide variations have been noted by other authors. For example, Shotwell (1967) illustrated a specimen of *A. valensis* (UO 26939) with an unusual double crest connection to a single anteroconid; a similar variant was noted by Martin (2008a) on an m1 (UWBM 57732) from the Hemphillian of northern Oregon. Moreover, Shotwell (1967) noted wide variation among specimens of *Copemys dentalis* from the Clarendonian Black Butte Local Fauna that includes many of the morphologies described herein. If such specimens do represent a very wide range of variation like that of extant *Peromyscus* (Hooper, 1957), many recently described taxa of brachydont cricetids may require revision.

Genus *Paronychomys* Jacobs, 1977

Paronychomys woodburnei Martin, 2008

Paronychomys sp. nr. *P. woodburnei*

Referred specimen—UWBM 58809, left M3 from the Wilbur 1 Locality (SDSM locality V8910=UWBM locality C0163).

Description—UWBM 58809 (Figure 7K) is a very hypsodont molar (A-P=0.9; Tr=0.8 mm) with bulbous expansion at the base of the crown. Hypsodonty and wear have combined to form fossettes on the occlusal surface rather than lophs. A short anterior cingulum appears as a short projection on the anterolingual side. The parafofsette is large, transversely oriented, and bifurcates buccally, whereas the metafofsette is short and ovate. The lingual reentrant (hypoflexus) is very deep and extends across the occlusal surface to touch the metafofsette; a buccal reentrant is shallow, short, and touches the posterior bifurcation of the parafofsette. Both reentrants could be removed with occlusal wear, leaving at least half of the crown height preserved. With occlusal wear, the anterior bifurcation could become isolated as a small fossette, at which time, UWBM 58809 would attain the wear stage of UWBM 57789, the type specimen of *Paronychomys woodburnei* from the Hemphillian Ordnance Locality. The worn pattern indicates a prominent paracone and protocone; the metacone and hypocone are reduced, as is the posterior cingulum.

Discussion—The hypsodonty and bulbous crowns of UWBM 58809 are similar to those of *Paronychomys* occurring in the late Hemphillian Arlington, Ordnance, and McKay Reservoir

localities of northern Oregon (Martin, 2008a) and unlike that of *P. shotwelli* (Korth, 2011) from the early Hemphillian Grassy Mountain Formation of southeastern Oregon. The size of UWBM 58809 is similar to that *Paronychomys woodburnei*, which also possesses a hypocone on M3 unlike that of *P. tuttlei* or *P. lemredfieldi* from the late Hemphillian Redington Local Fauna of Arizona (Jacobs, 1977). No M3 was described for *P. alticuspis* from the late Hemphillian White Cone Local Fauna of Arizona (Baskin, 1979), but this species is much smaller than the taxon represented by UWBM 58809. The last upper molar of rodents is often variable, but the hypsodonty, size, bulbous crowns, and hypocone on M3 suggest affinities with *Paronychomys woodburnei*. Only the larger posterior cingulum forming a more rounded posterior tooth margin of the M3 of the type specimen of *P. woodburnei* would prevent direct assignment. Until additional specimens of this taxon are recovered, UWBM 58809 is referred to as *Paronychomys* sp. nr. *P. woodburnei*.

Order Artiodactyla Owen, 1848

Family Camilidae Gray, 1821

Genus *Megatylopus* Matthew and Cook, 1909

Megatylopus, sp. indet.

Referred specimens—SDSM 86724, left C; UWBM 58819, left dentary fragment with dp3, dp4, m1; UWBM 58821, left astragalus; SDSM 86725, right astragalus; UWBM 58822, right calcaneum; SDSM 86728, right navicular; SDSM 15937, right metatarsal III-IV; SDSM 86731, distal epiphysis of metapodial III or IV; UWBM 58820, proximal phalanx; SDSM 86735, medial phalanx from the Wilbur 1 Locality (SDSM locality V8910=UWBM locality C0163).

Description—SDSM 86724 is a large (H=3.88 cm), relatively laterally compressed, distinctly recurved upper canine. A posterior carina has irregular blebs of enamel but is not typically serrate; the carina does not extend all the way to the tooth tip.

UWBM 58819 (Figure 8A, B) is a very fragmentary right dentary; the dp3 and the dp4 are relatively intact, but the m1 is badly broken. The dp3 has two long, slender roots, 1.5 times the crown height. The tooth exhibits moderate occlusal wear; the anterior portion of the tooth is blade-like, and a fossettid occurs in the posterior moiety at the posterolingual corner. The dp4 is moderately worn and composed of three lobes with complete crescents. The tooth is relatively low-crowned and lacks external styles. The m1 is also low-crowned, appears not to have erupted (no occlusal wear), and

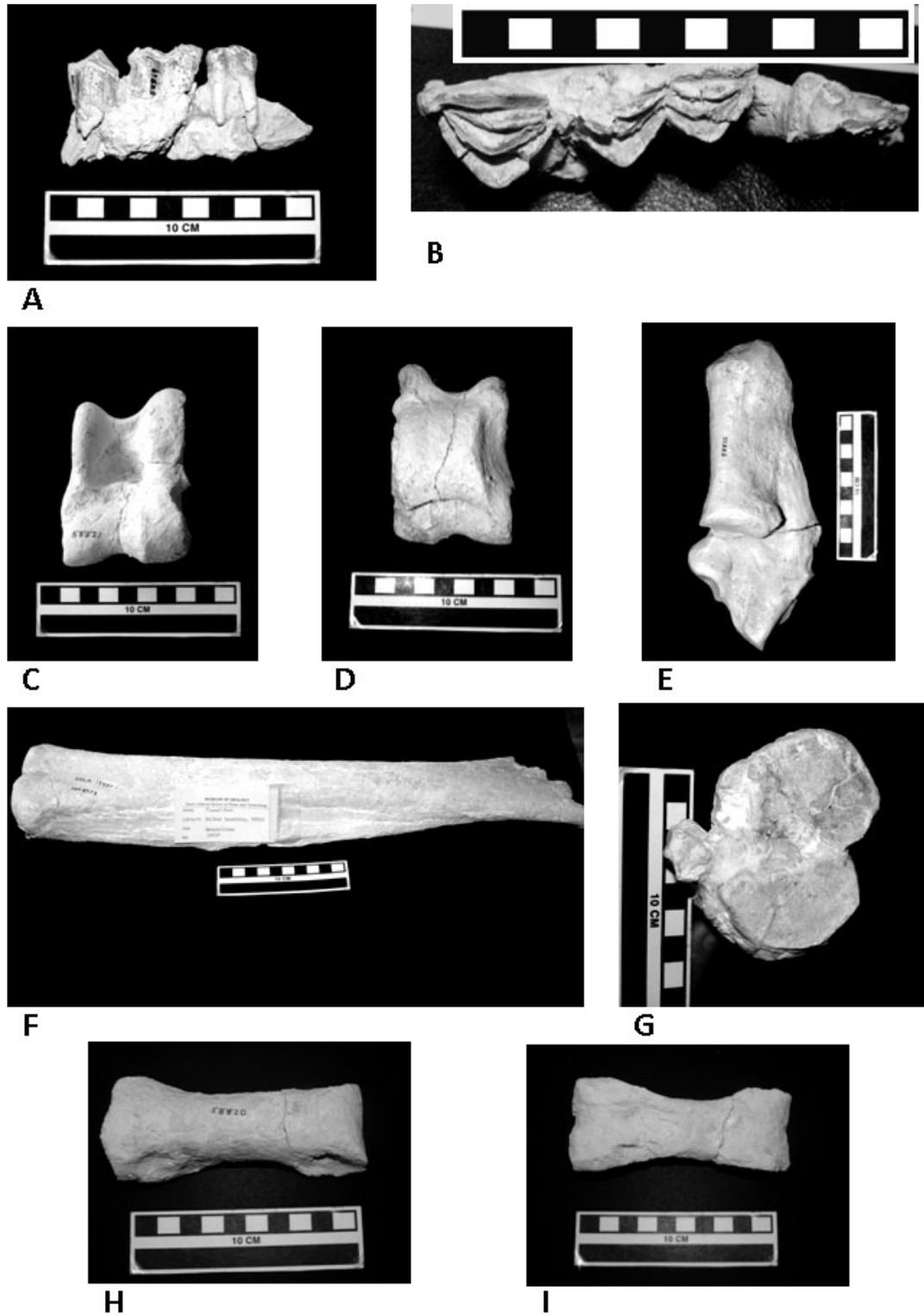


FIGURE 8. *Megatylopus*, sp. indet. A-B, UWBM 58819, left dentary fragment with dp3-dp4. A, lateral view. B, occlusal view. C-D UWBM 58821, left astragalus. C, dorsal view. D, ventral view. E, UWBM 58822, right calcaneum. F-G, SDSM 15937, right metatarsal III-IV. F, lateral view. G, proximal view. H-I, UWBM 58820, proximal phalanx. H, dorsal view. I, ventral view.

TABLE 6. Dental measurements in cm of *Megatylopus*, sp. indet, UWBM 58819, from the Wilbur Locality.

UWBM 58819	dp3	dp4	m1
A-P	2.0	5.9	--
Tr	1.0	1.7	--
H	1.35	2.2	4.2

may not have been fully formed. The specimen represents a juvenile individual (Table 6) that may be associated with the astragalus (UWBM 58821).

UWBM 58821, an astragalus (Figure 8C, D), is relatively small (Table 7), whereas SDSM 86725 is nearly as large as the largest specimen of *Megatylopus gigas* described from the Palmetto paleofauna from the latest Hemphillian Bone Valley Formation of Florida (Webb et al., 2008). Structurally, both astragali from the Wilbur Locality are very similar to those of *M. gigas*. The Washington specimens and those from Florida possess the lateral groove on the sustentacular facet. On UWBM 58821 the lateral margin of the sustentacular facet is nearly linear, which also occurs within the Florida sample, but normally the margin is curved. The distal end of the sustentacular facet is transverse, whereas those from Florida are normally oblique. Along this distal margin, a rounded projection commonly occurs in the Florida sample, but may be absent. UWBM 58821 is relatively symmetrical, whereas the distal ends of the astragali from Florida are transversely expanded, as are those of SDSM 86725. These variations may indicate two species of *Megatylopus* occur at the Wilbur Locality, but additional specimens must be obtained to determine whether the difference between the two Wilbur astragali is the result of speciation or merely ontogeny.

The calcaneum (UWBM 58822, Figure 8E) is extremely large (Table 8), larger than specimens from the Palmetto paleofauna. However, an astragalus within the Florida sample and SDSM 86725 are large enough to articulate with UWBM 58822. Other than size, only minor differences can be noted among the calcanea from Washington and Florida.

The navicular, SDSM 86728, is very large (DV=4 cm; Tr=6.22 cm), typically camelid, deeply cupped with an anteroposterior ridge lying just medial of center.

The metatarsal, SDSM 15937 (Figure 8F, G), is exceeding large, although broken across its distal end. The proximal articulation measures 6.7 cm anteroposteriorly and 8.35 cm transversely. The specimen is of the same relative size as the large

right calcaneum, right astragalus, and right navicular described above; these elements may have been derived from the same individual. SDSM 86731 is the distal epiphysis of a large camelid metapodial (Tr=4.25 cm). This specimen may belong with the juvenile dentary and smaller astragalus (UWBM 58821) as part of a second individual in the Wilbur assemblage.

The proximal phalanx, UWBM 58820 (Figure 8H, I), is long, relatively slender (Table 9), with a widely splayed distal articular end. Proximally, the phalanx possesses raised posterolateral ridges for suspensory ligaments. The element is relatively short proximal-distally but fits within the size range of the sample from the latest Hemphillian Whidden Creek Local Fauna from Polk County, Florida, especially UF 134750 and UF 13218.

A medial phalanx, SDSM 86735, is broken distally, but in other respects, preserves typical camelid morphology. The proximal transverse measurement of 4.3 cm indicates the large size of the taxon.

Discussion—These specimens are identical to specimens of *Megatylopus* from the Palmetto paleofauna from the latest Hemphillian Bone Valley Formation of Florida. Without the diagnostic upper dentition (P3), these specimens cannot be assigned to a species, particularly to Hemphillian *Megatylopus matthewi* or the more derived Hemphillian *M. gigas* or Blancan *M. cochrani* (Webb et al., 2008). Nevertheless, the exceedingly large size of the astragalus, calcaneum, and metatarsal represent one of the largest camelids to have ever existed.

Camelidae, small gen. et sp. indet.

Referred specimens—SDSM 86730, right navicular; SDSM 86726, distal epiphysis of metapodial III or IV from the Wilbur 1 Locality (SDSM locality V8910=UWBM locality C0163).

Description—The navicular is more poorly preserved and significantly smaller (DV=2.95 cm; Tr=4.3 cm) than the large camelid navicular, SDSM 86728, described above. SDSM 86730 and the distal metapodial epiphysis, SDSM 86726 (Tr=2.2 cm), are llama-sized and may represent a taxon such as *Hemiauchenia*.

Artiodactyla, fam. indet.

Referred specimen—SDSM 86729, partial scaphoid from the Wilbur 1 Locality (SDSM locality V8910=UWBM locality C0163).

Description—The broken scaphoid is from a medium-sized artiodactyl, but the preserved

morphology does not allow more precise designation.

AGE OF ASSEMBLAGE

The biostratigraphic ranges of a number of taxa from the Wilbur Locality are diagnostic of the Hemphillian NALMA. The badger, *Pliotaxidea*, the beaver *Dipoides wilsoni*, the new, relatively derived species of *Pliosacomys*, *P. witteorum*, and the chipmunk, *Neotamias malloryi*, occur only in the Hemphillian; the first appearances of *Castor* and *Megatylopus* occur in the Hemphillian; and most species of *Paronychomys* are also found in the Hemphillian. However, the precise portion of the Hemphillian represented by the Wilbur assemblage is problematical. Some taxa indicate early Hemphillian, although some taxa such as *Pliosacomys prowitteorum* are more derived than typical early Hemphillian counterparts. Some taxa suggest later Hemphillian time and are similar to late Hemphillian taxa from northern Oregon. Perhaps the Wilbur assemblage lies between typical early Hemphillian assemblages such as those occurring at Rome, OR, Rattlesnake, OR, and Thousand Creek, NV, and late Hemphillian assemblages from sites such as Ordance, Arlington, and McKay Reservoir in northern Oregon. This correlation suggests deposition of the Wilbur Locality after 7 Ma. Smith et al. (1989) derived a date of 7.41 ± 0.36 Ma from the Wilbur Locality. The tolerance of this date nearly coincides with the 7.05 ± 0.02 Ma date of the Rattlesnake Ash-Fall Tuff in central Oregon (Streck and Grunder, 1995). Therefore, the vertebrate biostratigraphy and radiometry derived from the Wilbur Locality appear to coincide.

CONCLUSIONS

The paleofauna from the Wilbur Locality was accumulated in south-central Washington during the Late Miocene Hemphillian NALMA. The reptiles and mammals were entombed in a diatomite that appears to have been formed in a shallow ponded/riparian area deposited during the unroofing of the Columbia River basalts during the Cascadian Orogeny. The overall lithostratigraphic unit is dominated by basalt gravels interbedded with volcanoclastic detritus and the diatomite, and on the basis of sequence stratigraphic and lithologic similarity, correlates with other Hemphillian units such as the Rattlesnake Formation of central Oregon,

the Madras Formation of north-central Oregon, and the Humboldt Formation of northern Nevada, and is probably slightly older than the Alkali Creek Formation and McKay Formation of northern Oregon, among others.

Within this assemblage are newly described taxa, including the turtle, *Wilburemys yakimensis* n. gen et sp., and a gopher, *Pliosacomys prowitteorum* n. sp.. *Wilburemys* is an emydid that appears to lie near the ancestry of the emyidine and deirochelyine divergence, but exhibits characters most similar to those of *Actinemys* and *Clemmys*. Of known fossil species, *Wilburemys yakimensis* is most similar to *Actinemys owyheensis* (Brattstrom and Sturn, 1959). However, the characters originally cited as diagnostic of *A. owyheensis* were variants among fossil and Recent specimens; therefore, the species is herein considered a *nomen dubium*. The geomyine, *P. prowitteorum*, appears to be the most derived species of *Pliosacomys* and lies on the evolutionary line leading to *Parapliosacomys*, particularly the least derived species of the genus, *Parapliosacomys witteorum*. *Pliosacomys prowitteorum* exhibits only incipient dental tracts on the cheek teeth but has attained monolophid, relatively hypsodont molars similar to more derived geomyines.

Overall, the Wilbur Local Fauna represents the only known Hemphillian assemblage recovered from the state of Washington. The assemblage and the basalt-dominated lithostratigraphic unit represent the most northerly occurrence of an important late Miocene succession in the Pacific Northwest. Similar vertebrate assemblages and generally similar lithologies occur elsewhere (e.g. Rattlesnake, Rome, and Madras, OR; Thousand Creek and Smiths Valley, NV) and signify a major geological and evolutionary chapter. This interval represents a major erosional cycle in the Cascade Mountains; the episode of unroofing of the Columbia River basalts resulted in basalt-dominated gravel sequences in basin fills from central Washington south into Nevada. Whether this erosional cycle is the result of tectonic uplift or sea-level drop (or both) cannot be positively ascertained. However the latter may be indicated as Hemphillian time records immigrant taxa from both South America and Eurasia (e.g. Tedford et al., 2004), indicating the reopening of major overland dispersal routes in the Northern Hemisphere.

TABLE 7. Astragalar measurements of *Megatylopus* in cm; UF specimens from Palmetto Paleofauna of Florida. Measurements in cm.

	UWBM 58821	SDSM 86725	UF134742	47240	134741	102674	162899
DV	8.61	11.2	9.4	9.9	10.35	10.5	12.0
Prox Tr	5.45	6.95	5.6	6.2	6.4	6.8	7.4
Dist Tr	5.71	7.3	6.65	6.7	7.1	7.2	8.0

TABLE 8. Measurements of calcanea of *Megatylopus* in cm; UF specimens from Palmetto Paleofauna of Florida

	UWBM 58822	UF134739	UF134740
DV	20.4	17.9	18.1
Tr	9.5	8.2	7.9

TABLE 9. Measurements of proximal phalanges of *Megatylopus* in cm; UF specimens from Palmetto Paleofauna of Florida.

	UWBM 58820	UF 134750	UF 13218	UF 134749	UF 134748
A-P	10.85	11.3	11.2	11.95	13.5
Prox Tr	4.65	4.6	4.9	5.1	5.05

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