

Equus occidentalis Leidy from “Asphalto,” Kern County, California

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ABSTRACT. The species *Equus occidentalis* Leidy, 1865, was initially described from three teeth, one recovered from an unknown locality in Tuolumne County, California, and the others from asphalt deposits inset into sediments of the Tulare Formation, Kern County, California. The single tooth from Tuolumne County is the lectotype. None of these teeth is sufficiently diagnostic to warrant specific distinction, and so *E. occidentalis* is generally interpreted to be a *nomen dubium*.

Another less common interpretation suggests that *E. occidentalis* may be a valid plesippine equid dating to the Blancan North American Land Mammal Age. This view is based upon plesippine characters exhibited by teeth of large *Equus* from the Asphalto fossil locality. At this site, lower cheek teeth of large *Equus* from outcrops of the Tulare Formation exhibit deep ectoflexids, a diagnostic character of plesippine equids.

Our investigation relocated the Asphalto site and its fossiliferous asphalt beds, examined equid fossils from the Tulare Formation to confirm their plesippine character, and directly examined the original types of *E. occidentalis* in order to assess their similarity to nonasphaltic fossils from the Tulare Formation. Efforts to relocate Asphalto were successful, but encountered only oil-saturated sands of the Tulare Formation—not asphalt beds. Nonasphaltic localities in the Tulare Formation contain abundant remains of plesippine equids, but these fossils—and other vertebrate remains from the formation—lack the deep asphalt staining characteristic of Leidy’s types from this region. In contrast, fossils in Leidy’s original type series are heavily impregnated with asphalt, resembling abundant fossil remains from the nearby McKittrick asphalt deposits. Leidy’s type series also includes previously unpublished topotypes representing a derived, nonplesippine equid similar to the Late Pleistocene large horse species represented at McKittrick.

We propose that Leidy’s original fossils of *E. occidentalis* from northwest of Buena Vista Lake are most likely from the McKittrick asphalt deposits, rather than from the Asphalto paleontological locality. Based upon actual topotypes comprising Leidy’s original type series, *E. occidentalis* is a derived horse closely resembling the large Pleistocene horses from localities such as McKittrick, Maricopa, and Rancho La Brea. The species cannot be considered a plesippine horse and is unlikely to date to the Blancan NALMA.

INTRODUCTION

Pleistocene horses (genus *Equus*) in North America are emblematic of taxonomic confusion, due in part to the prevalence of skeletal remains of these animals in the fossil record. Bones and especially teeth of horses are common components of numerous Pleistocene terrestrial vertebrate faunas and have been since the early days of paleontology. Because many fossils of *Equus* were

discovered in years when the naming of species was not strictly codified and the full morphological variability of those remains had not been quantified, nominal species names proliferated. While many of these early names have retreated into obscurity, some have continued in use despite inadequate type material.

The species *Equus occidentalis* Leidy, 1865, is a case in point. Originally named from two upper premolars and one lower molar from two widely separated geographic localities, the species has subsequently been the subject of much confusion. Interpretations include (1) *E. occidentalis* as a valid Late Pleistocene species (e.g., Merriam, 1913; Bennett, 1980; Kurtén and Anderson, 1980), (2) *E. occidentalis* as a valid early Pleistocene plesippine species (e.g., Savage, 1951; see also MacFadden, 1998), and (3)

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E. occidentalis as a *nomen dubium* and/or a *nomen vanum* (e.g., Miller, 1971; Winans, 1985; Scott, 2004).

Of these, the interpretation advanced by Savage (1951:246) that *E. occidentalis* was “a valid species of plesippine affinity” is considered here.

ABBREVIATIONS

BVM	Buena Vista Natural History Museum, Bakersfield, California
SBCMC	San Bernardino County Museum, Redlands, California
UCMP	University of California Museum of Paleontology
VPM	Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts

BACKGROUND

The species *E. occidentalis* Leidy, 1865, was named on the basis of three teeth: a left P3 from the auriferous clays of Tuolumne County, California (VPM 9129), and a right P3 (VPM 9130) and right m3 (VPM 9131) from “a bed of asphaltum ... near Beuna [sic] Vista Lake” (Leidy, 1865:94) in Kern County, California. None of these was selected as a holotype, likely because the need for designation of a type was not yet fully recognized at the time the species was named (see Dayrat, 2010). The defining character of *E. occidentalis* was interpreted to be “the remarkable degree of simplicity of the enamel folding, as seen on the tritulating surfaces” (Leidy, 1865:94). This definition was augmented (Leidy, 1869:267) to note “the absence of the little fold of enamel ... near the bottom of the deep valley between the median- and posterior internal folds of the tritulating surface” (i.e., the pli caballin).

Although the discussion of enamel simplicity in the initial publication could be readily ascribed to all of the available teeth, the subsequent mention of the lack of pli caballin could only apply to the upper teeth, since this feature does not occur in lower teeth. This is actually a point of some significance, because subsequent to Leidy’s (1865) naming of the species, the available literature makes no mention of the right m3 referenced in the initial description.

Leidy’s 1869 paper considered the fossils previously assigned to *E. occidentalis* to resemble upper teeth of the species *Equus excelsus* Leidy, 1858, in both the simplicity of the enamel patterns on the wear surface and in the lack of pli caballin. Although the fossils of *E. excelsus* derived from Nebraska, Leidy (1869) nevertheless considered the California teeth to belong to that same species. This interpretation was promulgated by Leidy (1873), although in this later paper taxonomic priority was erroneously assigned to *E. occidentalis*.

Whitney (1880:256) published some of Leidy’s notes on the fossils, with the view that it was

“proper to publish in full the notes furnished by [Leidy] in regard to the equine remains examined, although some years have elapsed since [these notes] were written.” These notes describe in somewhat more detail fossils previously mentioned in passing by Leidy (1869, 1873) as belonging to *E. occidentalis* (or *E. excelsus*) in addition to the type material—although, as noted, the “last lower molar” referred to by Leidy (1865:94) is not included. Whitney (1880:256) is more specific as to the locality producing the specimens “imbued with bitumen,” again referencing the Buena Vista Lake region but stating in a footnote that “[t]he exact locality is believed to be the ‘Sta. Maria Oil Springs’, about twelve miles northwest of the north end of Buena Vista Lake.”

Cope (1884) and Gidley (1901) considered *E. occidentalis* to be distinct from *E. excelsus*; the latter review selected the Tuolumne County premolar (VPM 9129) as the lectotype of *E. occidentalis*. This was largely the state of affairs when Merriam (1913) assigned the entire sample of horses from Rancho La Brea, Los Angeles County, California, to *E. occidentalis*. At this point, there is a substantial shift in the literature, as most subsequent papers making reference to *E. occidentalis* reference the fossil horses from Rancho La Brea rather than Leidy’s original suite of fossils.

Savage (1951) disagreed with Merriam’s (1913) interpretation, considering *E. occidentalis* to be a valid species separate from the Rancho La Brea equid. Because Savage’s analysis is a primary focus of the present study, his reasoning is presented here verbatim:

“*Equus occidentalis* Leidy [1865] was based on an upper cheek tooth from the ‘Pleistocene auriferous gravels’ in Tuolumne County, California, and two upper cheek teeth from an asphalt bed near Buena Vista Lake in Kern County, California. The latter locality is now usually called Asphalto. These teeth are all characterized by a simple and somewhat rectilinear enamel pattern and a broad lingual groove on the protocone. It is impossible to get topotypes of the Tuolumne County specimen, because the exact locality was never specified; it may or may not be Pleistocene in age. [University of California Museum of Paleontology director R.A.] Stirton (oral communication, 1948) has called to my attention that topotypal lower cheek teeth from Asphalto bear the plesippine V-shaped groove between the metaconid and metastylid [= the linguaflexid]. Merriam [1913] referred the abundant horse material from Rancho La Brea to *E. occidentalis*. Although there is remarkable identity in characters between the Rancho La Brea horse and the types of *E. occidentalis*, the La Brea horse is a true caballine ... and must be referred to some other species. *E. occidentalis* is believed to be a valid species of plesippine

affinity.... The Blancan [North American Land Mammal Age] age assignment for [*E. occidentalis*] is supported by the recovery of *Ischyrosmilus* and *Borophagus* from Asphalto." (Savage, 1951:246)

A key point in this discussion is Savage's (1951) mention of the locality name Asphalto; this is the first occurrence of this locality in this context, as the name did not occur in Leidy's original (1865) description of *E. occidentalis* nor in any of his subsequent discussions of the species. The Asphalto region, located around present-day McKittrick, was named for early exploration and asphalt mining camps northwest of Buena Vista Lake; the original camp was established in the later 1860s, but the first camp was not actually named Asphalto until 1891 (Brewer, 2001). The third and final Asphalto camp was renamed McKittrick in 1900 (Brewer, 2001).

The issue is further confused in that there is also a fossil locality named Asphalto from the same general region. The Asphalto paleontological locality, UCMP 1365, is recorded approximately 2.6 km (1.6 miles) southeast of present-day McKittrick in Kern County, California. The locality is documented from outcrops of the Tulare Formation, a thick succession of nonmarine, poorly consolidated sandstone, conglomerate, and claystone beds exposed intermittently along the western border of the San Joaquin Valley (Woodring et al., 1932; Maher et al., 1975). The formation is composed of two distinct lithologic units, separated on the basis of the color of the mudstones. The lower unit is made up of alternating layers of olive-grey gypsiferous mudstone and cross-bedded grey feldspathic sandstone containing lenses and irregular stringers of conglomerate; the upper lithologic unit resembles the lower unit, save that the mudstone layers are buff in color while the sandstone layers near the top of the unit include pebbles representing a diversity of rock types (Maher et al., 1975). The formation has been dated from 2.5 to 0.6 Ma (Scheirer and Magoon, 2007).

The Asphalto locality yielded the holotype left and right dentaries (UCMP 8139) of "*Hyaenognathus pachyodon* Merriam, 1903" (= *Borophagus diversidens* Cope, 1892) and the genotype mandible (UCMP 8140) of "*Ischyrosmilus* Merriam, 1918" (= *Homotherium* Fabrini, 1890). Both these carnivorans date to the Blancan North American Land Mammal Age (NALMA), which is consistent with the proposed geologic age of the Tulare Formation (Scheirer and Magoon, 2007). These fossils are light in color, showing no evidence of asphalt staining or impregnation.

Other vertebrate fossils have also been reported from the Tulare Formation, but most have not previously been described in any detail. Repenning (1980, unpublished report reprinted in part in Miller, 1999) listed multiple taxa from the formation, including two species of horse, *Equus*

(*Hemionus*) "*callobatus*" (= *Equus calobatus* Troxell, 1915) and "*E. (H.) occidentalis*." However, the morphological characters upon which these species assignments were made have not been published, and so these assignments remain unverified. Repenning (1980) also reported the presence of *Hypolagus furlongi* Gazin, 1934, and *Sigmodon medius* Gidley, 1922, in the assemblage from the Tulare Formation; these taxa are also indicators of a Blancan NALMA date for the fossils.

It appears that Savage (1951) and subsequent researchers conflated Asphalto as a general geographic region with Asphalto the specific paleontological locality. Following from this, the assertion that lower cheek teeth of plesippine *Equus* from the region could be used to supplement the definition of *E. occidentalis* Leidy (which was based upon upper teeth) seems reasonable. Further, the Blancan age for the fossils from the Tulare Formation could be applied to *E. occidentalis* if Asphalto was actually the site producing Leidy's fossils.

Some subsequent reviews have called Savage's (1951) interpretation into question. For example, Dalquest (1978) argued that Gidley's (1901) selection of the specimen from Tuolumne as the lectotype of *E. occidentalis* should be retained under Article 73 of the International Rules of Zoological Nomenclature. The plesippine character of the "topotypal" lower cheek teeth from Asphalto described by Savage (1951) was therefore not considered relevant in the diagnosis of the taxon. In contrast, MacFadden (1998) considered *E. occidentalis* to be roughly synonymous with the Blancan plesippine equid *Equus simplicidens* Cope, 1892, which suggests that this study agreed at least in part with *E. occidentalis* being a plesippine as proposed by Savage (1951).

However, in this context it is important to emphasize that Leidy (1865, 1869, 1873) and Whitney (1880) never mentioned Asphalto in any of their discussions of *E. occidentalis*. In fact, they could not have done, since the first Asphalto settlement was not established until 1891 (Brewer, 2001). Rather, Leidy and Whitney made repeated mention of Buena Vista Lake as their point of reference, probably because that was the major geographic feature of the region in the mid-nineteenth century. Here, Whitney's (1880) reference to the Santa Maria Oil Springs northwest of the north end of Buena Vista Lake may be telling, since there are extensive asphalt beds in this general region: the McKittrick asphalt seeps (Schultz, 1937; Church, 1968), located approximately 27 km (17 miles) northwest of the northern extent of former Buena Vista Lake. These extensive beds of asphalt, situated adjacent to the southern end of the Little Santa Maria Valley, are inset into older sediments of the Tulare Formation but postdate that unit (Schultz,

1937). The McKittrick seeps have yielded abundant remains of Late Pleistocene megafauna, of which *E. occidentalis* is reported to be the most abundant large herbivore, based upon minimum numbers of individuals (Torres, 1989). The fossils excavated from these deposits are all dark stained due to impregnation by asphalt.

Based upon this review, there are two well-established paleontological localities, Asphalto and McKittrick, that might have produced the type series of *E. occidentalis* Leidy from “northwest of the north end of Buena Vista Lake” (Whitney, 1880:256). Since these localities are of differing geologic ages—Asphalto dating to the Blancan NALMA, McKittrick to the Rancholabrean NALMA—the assumption by Savage (1951) that the Asphalto locality yielded some of Leidy’s original type series of *E. occidentalis* is called into question. The present study examines this concern.

METHODS

In order to assess the viability of Savage’s (1951) interpretation of the validity of *E. occidentalis* Leidy, a three-pronged approach included (1) field visits to the Asphalto region, including to established paleontological localities, to assess whether or not exposed beds of asphaltum were present regionally; (2) direct examination of fossils from the Tulare Formation in museum collections, to confirm or refute whether or not they possess plesippine characters; and (3) examination of Joseph Leidy’s original series of fossils assigned to *E. occidentalis*, including the types as well as additional, previously undescribed fossils.

A field survey of the Asphalto region was conducted by two of us (K.E.B. and E.S.) in August 2013; the area had been previously visited by W.A.A. in 1972. The survey was based upon historic maps and early United States Geological Survey topographic quadrangle maps showing Asphalto as a geographic locale. The survey also examined paleontological locality UCMP 1365 and the surrounding area, based upon locality data from the UCMP online locality database. Survey was conducted on foot.

Fossils of large *Equus* from the Tulare Formation were examined by K.E.B. and E.S. in the collections of the Buena Vista Natural History Museum and the San Bernardino County Museum.

Leidy’s original type series of *E. occidentalis* was directly examined and photodocumented by E.S. in the collections of the Museum of Comparative Zoology in June and December 2013.

RESULTS AND DISCUSSION

RELOCATING ASPHALTO

The field survey relocated geographic (as opposed to paleontological) Asphalto as documented on early US Geological Survey maps near a railroad

line extending from the community of McKittrick in an east-southeast direction, then veering toward the northeast. Asphalto was marked on these maps near the center of section 22, Township 30 south, Range 22 east, Mount Diablo Base and Meridian, roughly 2 km (1.2 miles) due east of present-day McKittrick. Finding this original locality was instrumental in determining where the fossils were collected. Satellite photographs of the area from Google Maps revealed the old railroad grade, establishing that this was indeed the site of an old rail line. Historical artifacts were also discovered at the site, including broken bottles, railroad ties, and rail spikes, verifying the presence of an old railroad. However, we found no evidence of asphaltum deposits, confirming that the fossils were not found at this locality.

Paleontological locality UCMP 1365 is situated in the western half of section 27. Foot surveys of this area revealed multiple outcrops of petroleum-impregnated sands and gravels, consistent with published descriptions of the Tulare Formation (Fig. 1), but located no substantive beds of asphaltum. No fossils were observed at either of these two sites.

LARGE *EQUUS* FROM THE TULARE FORMATION

Teeth of large *Equus* from the Tulare Formation in the collections of the BVM include both upper and lower cheek teeth collectively catalogued under number BVM 6001. Lower molars in this collection clearly exhibit plesippine characters including a V-shaped or narrow U-shaped linguaflexid discussed by Savage (1951), as well as a deep ectoflexid (Fig. 2A). The equid represented by these specimens appears to be of moderate to large size.

Similarly, fossils of large *Equus* in the collections of the SBCM also include specimens of upper and lower cheek teeth. Here, too, lower molars exhibit plesippine characters, including the narrow linguaflexid and molar ectoflexids that penetrate the isthmus (Fig. 2B). These fossils represent a very large plesippine horse, likely *Equus idahoensis* Merriam, 1918, or a closely related form.

All of these fossils exhibit a very light, white or off-white color and show no trace of asphalt staining or impregnation. This coloration is consistent with other fossils reported from the Tulare Formation, including the holotype of “*Hyaenognathus pachyodon*” and the genotype of “*Ischyrosmilus*.”

LEIDY’S TYPE SERIES AND SUPPLEMENTAL FOSSILS OF *EQUUS OCCIDENTALIS*

Specimens VPM 9129, VPM 9130, and VPM 9131 collectively constitute Leidy’s type series for



Figure 1 Outcrop of the Tulare Formation in the near vicinity of the Asphalto paleontological locality, UCMF 1365. The outcrop consists of well-sorted sands saturated with oil. View is to the southeast. Author K. Brown for scale.

E. occidentalis. VPM 9129 is the left P3 from Tuolumne County, selected by Gidley (1901) as the lectotype; this specimen is not considered further here. VPM 9130 is the right P3 “obtained from a bed of asphaltum, *in company with a last lower molar*, near [Buena] Vista Lake” (Leidy, 1865:94; emphasis added).

VPM 9131 is an adult right m3 in full wear (Fig. 3). Because it is numbered sequentially with VPM 9129 and VPM 9130, and because it is the only m3 available in Leidy’s type series as presently constituted, and because it is asphalt stained, as is VPM 9130, it is almost certainly the “last lower molar” from the Buena Vista Lake region referenced by Leidy (1865:94) in his initial description of *E. occidentalis*. (This is contrary to the mistaken assertion by Savage [1951:246] that the type series included “two upper cheek teeth from an asphalt bed near Buena Vista Lake.”) The tooth exhibits a shallow, broad, U-shaped linguaflexid and a shortened ectoflexid that does not penetrate the molar isthmus (Fig. 3). These characters differ markedly from the plesippine condition observed in lower molars of *Equus* from the Tulare Formation, which possess narrow linguaflexids and ectoflexids that penetrate the molar isthmus.

In addition to Leidy’s type series, the collections of the Museum of Comparative Zoology also hold additional fossils mentioned by Leidy

(1869, 1873) and Whitney (1880) that have otherwise remained undocumented. Like the type series, these other fossils also derive from “the Asphaltum bed or spring, near Buena Vista Lake, California” (Leidy, 1869:267). Among these fossils, a partial mandible (including VPM 9143, left horizontal ramus; VPM 9144, right horizontal ramus; and VPM 9146, symphyseal region) also clearly exhibits a number of nonplesippine characters, including broad, U-shaped molar linguaflexids and molar ectoflexids that do not penetrate the molar isthmus (Fig. 4). These characters are also exhibited by a partial left dentary, VPM 9141 (Fig. 5).

It is apparent that these asphalt-impregnated specimens, mentioned although never fully described by Leidy (1869, 1873) and Whitney (1880), are actual topotypal fossils of *E. occidentalis*. None of the fossils exhibits any plesippine characters but, instead, resemble more derived Late Pleistocene *Equus*—including specimens of large *Equus* from the McKittrick asphalt seeps, as well as from other asphalt localities in southern California including Rancho La Brea (Stock, 1992) and Maricopa (Torres, 1989). Their morphology contrasts sharply with the description provided by Stirton to Savage in 1948 (as reported by Savage, 1951) referencing plesippine characters in “topotypal” cheek teeth from Asphalto; this description very likely refers to horse teeth from the Early to

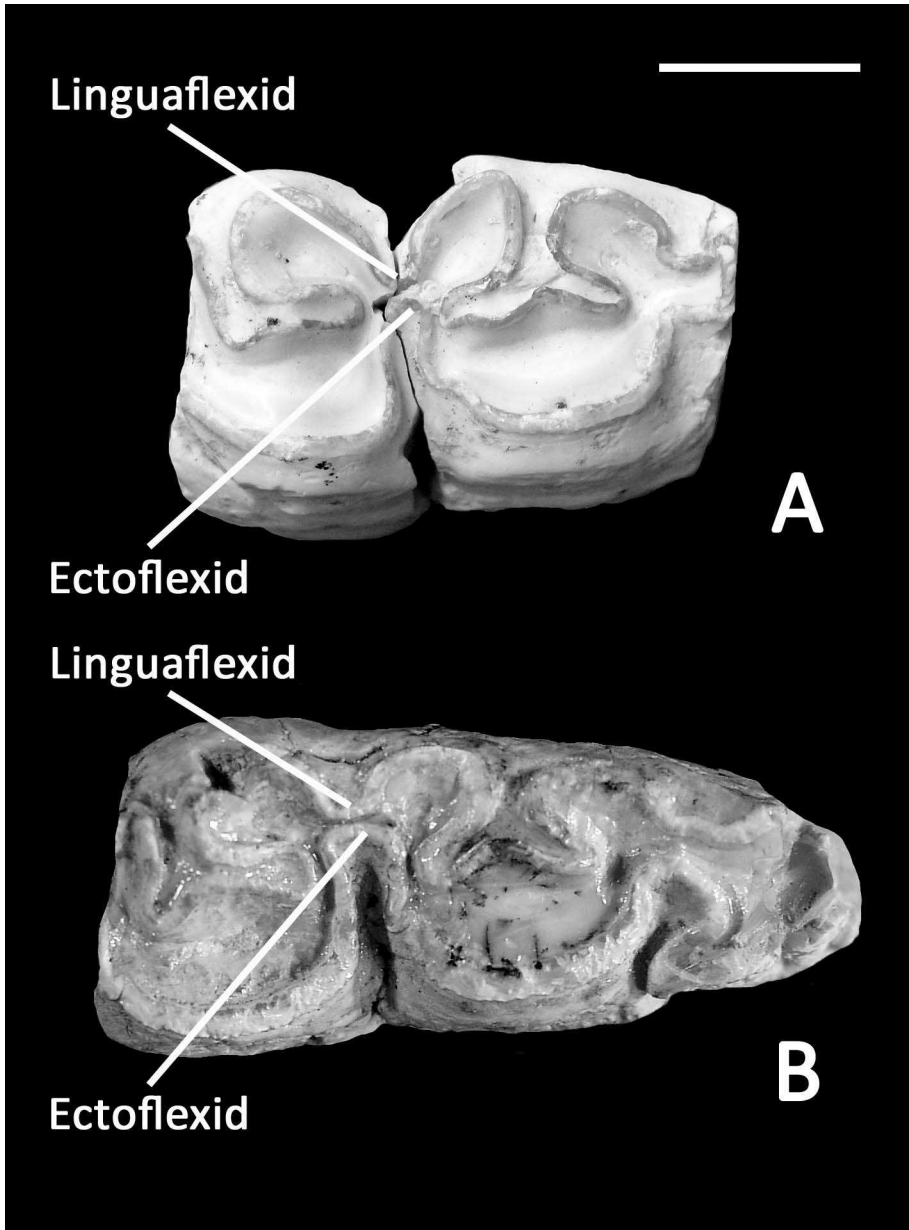


Figure 2 Lower molars of *Equus* from the Tulare Formation. Anterior is to the left. **A.** BVM 6001, left lower molar, occlusal view; **B.** SBCM A3029-1977, left m3, occlusal view. Both specimens exhibit plesippine characters, including a narrow linguaflexid and a long ectoflexid that penetrates the molar isthmus. Scale = 1 cm.

Middle Pleistocene age Tulare Formation, which despite their potential geographic proximity are likely not true topotypes *sensu stricto*.

CONCLUSIONS

The species *E. occidentalis* Leidy, 1865, was named in part from specimens obtained from asphalt beds northwest of Buena Vista Lake in Kern County, California. Although the lectotype

of the species is from a different locality, some researchers (notably Savage, 1951) proposed that the Kern County fossils can be used, together with other horse fossils from that region, to establish *E. occidentalis* as a valid plesippine equid species dating to the Blancan NALMA. This interpretation assumes that Leidy's Kern County fossils derived from the Asphalto paleontological locality, or from a site of similar age and depositional constraints.

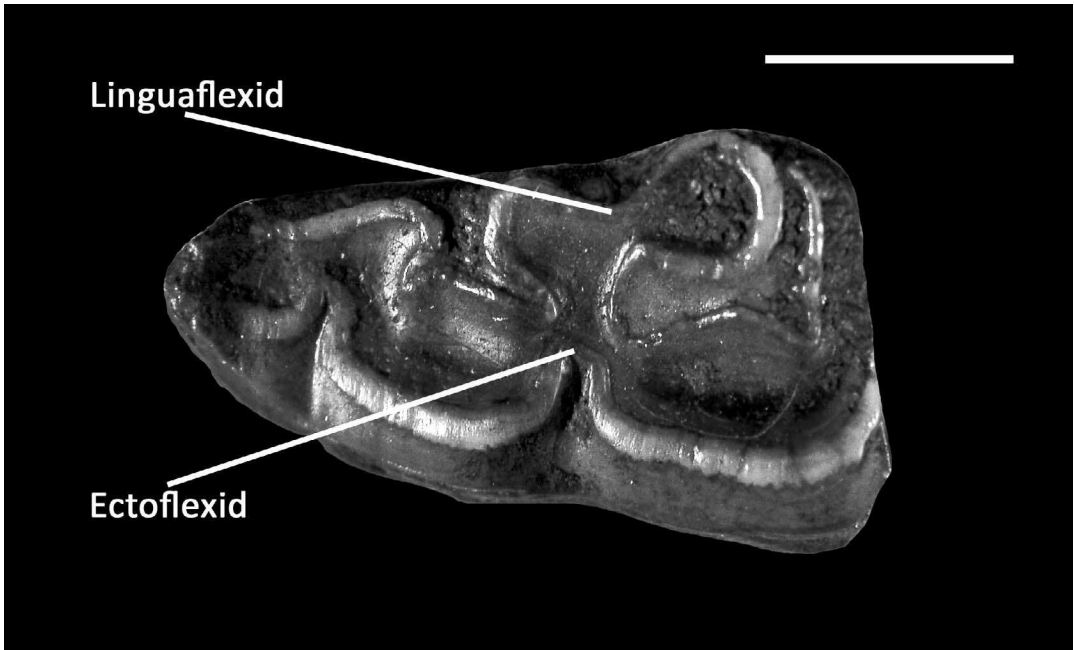


Figure 3 VPM 9131, right m3, occlusal view. Anterior is to the right. This specimen is the “last lower molar” referenced by Leidy (1865) in his initial description of *Equus occidentalis*; this specimen, part of the original type series for the species, has not previously been described or figured. VPM 9131 possesses a broad, shallow linguaflexid and an ectoflexid that approaches but does not penetrate the molar isthmus; compare with the plesippine condition observed in SBCM A3029-1977 (Fig. 2). Scale = 1 cm.

We propose that the teeth of Leidy’s type series of *E. occidentalis*, stated to derive from near Buena Vista Lake, are in fact from the McKittrick asphalt beds, and not from Asphalto at all. This interpretation is consistent with the geography and geology of the region, with the original published mentions of the locality in question, and with the nature of the fossils themselves. Nor is this interpretation new. Schultz (1937) stated:

“The first mention of vertebrate remains from the McKittrick region seems to have been made by Joseph Leidy (1865, p. 94), who described two horse teeth from the vicinity of Buena Vista Lake and referred them to *Equus occidentalis* [underlined in original]. Additional horse material from this locality was described and figured by Leidy in 1873 (pp. 242–244, pl. 33, fig. 1). Whitney (1880, p. 256) stated that Leidy’s specimens were obtained from Santa Maria Oil Springs, a locality



Figure 4 VPM 9144, right lower cheek tooth row with p2 through m2, occlusal view. Anterior is to the right. These teeth are part of a partial mandible mentioned by Leidy (1869, 1873) and Whitney (1880) as belonging to *Equus occidentalis* and deriving from the same locality yielding the original type series. This specimen has not previously been figured. The molars (left two teeth) lack any plesippine characters but, instead, exhibit broad, rounded linguaflexids and shortened ectoflexids. Scale = 1 cm.



Figure 5 VPM 9141, left lower cheek tooth row with p2 through m2, occlusal view. Anterior is to the left. These teeth are from material mentioned by Leidy (1869, 1873) and Whitney (1880) as *Equus occidentalis* from the same locality yielding the original type series. This specimen has not previously been figured. The molars (right two teeth) exhibit broad, rounded linguaflexids and shortened ectoflexids. Scale = 1 cm.

approximately two miles to the southwest of McKittrick.” (Schultz, 1937:5)

We agree with Schultz’s (1937) interpretation. We emphasize that this does not indicate that the McKittrick and Asphalto paleontological localities are one and the same; different and geographically separate locality data are available for each, demonstrating that they are separate localities (Holroyd, personal communication, 2013).

It is of course possible, given the extensive asphalt mining and petroleum extraction conducted in and around the McKittrick region since Leidy first published on the remains of *E. occidentalis*, that any fossiliferous asphalt beds once located in the Asphalto area may have been completely excised. However, given that similar asphalt mining also took place at the McKittrick asphalt seeps, which remain extant, we conclude that the beds of asphaltum referenced by Leidy (1865, 1869, 1873) are more likely to be the McKittrick beds themselves. The nature of the fossils included in Leidy’s type series supports this contention.

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