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A LATE CLARENDONIAN LOCAL FAUNA FROM THE GOLIAD FORMATION OF SOUTH TEXAS

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ABSTRACT

This paper describes the Dinero Local Fauna, a small collection of fossils from a roadcut in the Goliad Formation in Live Oak County, Texas. It is from higher in the section than the classic early Clarendonian Lapara Creek Fauna. Four mammalian taxa are present: the rodent *Ceratogaulus* cf. *anecdotus*, and the equids *Pseudhipparion skinneri*, *Cormohipparion* cf. *ingenuum*, and *Calippus* cf. *cerasinus*. The co-occurrence of these taxa is consistent with the late Clarendonian age assignment.

INTRODUCTION

Baskin and Hulbert (2008) presented a revised biostratigraphy of the Goliad Formation in southeastern Texas. Goliad Formation fossils are housed in the Vertebrate Paleontology Laboratory of the University of Texas, Austin (TMM). The classic Goliad localities are in Bee and Live Oak Counties and comprise the Lapara Creek Fauna (Figure 1). Quinn (1955, fig. 5) noted five major localities for the Lapara Creek Fauna, but included numerous others. They are from low in the section, and include TMM 31132, the Normanna or Bridge Ranch Local Fauna (LF), and TMM 30896, the Berclair or Farish Ranch LF (Sellards, 1940; Quinn, 1955; Wilson, 1956; Tedford and others, 1987, 2004). The horses *Hypohippus affinis*, *Neohipparion affine*, *Pseudhipparion curtivallum*, *Calippus placidus*, *C. regulus*, *C. martini*, *Protohippus supremus*, *Cormohipparion occidentale*, and *C. ingenuum* confirm an early Clarendonian (12-13 Ma) age assignment (Forstén, 1975; Webb and Hulbert, 1986; Hulbert 1987, 1988b, 1988c). One of the minor localities noted by Quinn is TMM 31263 ("at Sweeney [sic] Switch on roadcut hwy 9, George West to Dinero Rd., Live Oak County" of Forstén, 1975, p. 66). Swinney Switch is located at the intersection of Farm roads 534 and 3024, 20 km northwest of Mathis. TMM 31263 is in a roadcut 1 km north of this intersection. A photograph of the locality appears in Weeks (1945, fig. 23). Fossils were recovered from coarse, cross-bedded sands that are held together by calcite cement (Baskin and Hulbert, 2008). The 8-m-thick sand is just below a 1.5 m calcrete cap of the Goliad and above a 2-m-thick pink/red clay that Weeks noted formed a wedge. Weeks (1945) divided the Goliad into a lower Lapara unit and an upper "Lagarto" unit. Although he did not state so explicitly, the combination of calcareous sand and red clay indicate he considered the roadcut as part of the upper "Lagarto" unit. Eargle (1968) assigned the 44 ft section that he measured at the roadcut to the middle part of the Goliad Sand. Baskin and Hulbert (2008) named the assemblage from this locality the Dinero LF and assigned it to the late Clarendonian North American Land Mammal Age. They briefly noted the taxa that justified this assignment. The present paper illustrates and more fully describes these species.

METHODS

Measurements in millimeters were made with digital calipers. Dental terminology for mylagaulids follows Webb (1966), Baskin (1981), and Korth (2000). Dental terminology for horses follows MacFadden (1984) and Hulbert (1988a) as emended by Evander (2004).

SYSTEMATIC PALEONTOLOGY

Order Rodentia Bowdich, 1821
Family Mylagaulidae Cope, 1881
Ceratogaulus Matthew, 1902
Ceratogaulus cf. *anecdotus* Korth, 2000
Figure 2

Referred Specimens—TMM 31263-6, left P4; -10, partial right p4.

Description—The P4 (L=9.2, W=5.3, H=13.0) has eight lakes. From anterior to posterior on the

FIGURE 1. Map of study area. early Clarendonian Lapara Creek Fauna localities, 1 (Bridge Ranch) and 2 (Farish Ranch); 3, Dinero LF; 4, Labahia Mission Fauna. Exposures of the Goliad Formation outlined in black indicated by Mg. Live Oak, Bee, and Goliad Counties outlined with dashed lines.

external side, the anterofossette is elongate, extending not quite half the length of the tooth; the parafossette overlaps about 2/3 of the anterofossette and extends just past the midline of the tooth; and the metafossette consists of two lakes, the internal lake is about half as long as the more external one. Internally, the protofossette consists of two lakes of nearly equal length. There is a small fossette in between the anterofossette and the hypofossette. A partial, lightly-worn tooth is tentatively identified a the anterior portion of a p4, because the unbroken end is relatively narrow. If this is correct, the anterior-most fossetid is "V"-shaped.

Comparisons—Korth (1999, 2000) described and reviewed the six genera of Hemingfordian to Hemphillian mylagaulines. The late Hemingfordian to early Barstovian *Alphagaulus* (Korth, 2000) is smaller than the Dinero specimen (maximum P4 length = 9.0), has fewer fossettes, and the parafossette is Y-shaped. The Barstovian to Hemphillian *Pterogaulus* (Korth, 2000) is from the northern Great Plains, and has fossettes more anteriorly-posteriorly oriented than the Dinero specimens. The Barstovian to Hemphillian *Hesperogaulus* (Korth, 1999) is known only from the Great Basin and also has forked parafossette on the P4, unlike the Dinero P4. The P4 of the late Barstovian to Hemphillian *Mylagaulus* is characterized by having a C-shaped metafossette. The Barstovian *Umbogaulus* has a P4 that is relatively round in occlusal outline and with a "Y"-shaped parafossette until very late wear.

Korth (2000) determined that *Ceratogaulus* (Matthew, 1902) is the senior subjective synonym of *Epigaulus* (Gidley, 1907). There are four named species. *Ceratogaulus hatcheri* (the type species of *Epigaulus*), from the Hemphillian of Kansas, is the largest species, with P4 measuring 13.0 x 8.0 (Gidley, 1907). *Ceratogaulus minor* is from the Clarendonian of Kansas (Hibbard and Phillis, 1945). The type specimen is from an old adult, and the P4 has 6 enamel lakes and measures 9.1 x 7.5, with a width to length ratio of 0.82. The Dinero P4 most closely resembles the illustrations of *Ceratogaulus* cf. *rhinocerus* from the Burge quarry (Korth 2000, fig. 15C) and of *C. anecdotus* from the Merritt Dam Member of the Ash Hollow Formation (Korth 2000, fig. 17A). In *C. rhinocerus*, the width to length ratio of P4 is >0.70; in *C. anecdotus*, 0.64-0.66 (Korth, 2000). In the Dinero specimen, it is 0.58. If the V-shaped anterior fossettid on the p4 is correctly identified, then this, along with the characters of the P4, indicates the specimens are best referred to *C.* cf. *anecdotus*.

Comment—This is the first mylagaulid described from the Gulf Coastal Plain outside of Florida (Wood, 1947, Webb, 1966; Baskin, 1981, Morgan and Pratt, 1988, Bryant, 1991). Although Wilson (1962, p. 349) noted the presence of *Mylagaulus* in the early Barstovian Burkeville fauna, this is likely a misidentification of the beaver *Amblycastor*. Undescribed mylagaulids do occur in the early Clarendonian Lapara Creek Fauna at Bridge Ranch. Elsewhere in Texas, mylagaulids are known from the Clarendonian and Hemphillian of the Texas Panhandle (Schultz, 1990).

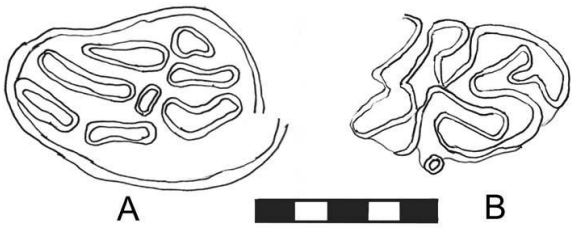

FIGURE 2. *Ceratogaulus* cf. *anecdotus* from Dinero LF, A, TMM 31263-6, left P4; -10, partial right p4; scale = 5 mm.

Order Perissodactyla Owen, 1848
Family Equidae Gray, 1821
Pseudhipparion Ameghino 1904
Pseudhipparion skinneri Webb and Hulbert, 1986
Figure 3, Table 1

Referred Specimens—TMM 31263-11, right P2; -12, right M3; -13, right M1; -14, right M1 (possibly associated with -11); -15, worn right upper cheek tooth; -30, left dp3; -31, right dp3; -16, right p3 or p4; -4a, -24, left m1 or m2; -27, right m1 or m2; -25, right m3.

Description—P2. The parastyle (anterostyle of some previous authors) is relatively short, the anterior accessory rib (parastyle of some previous authors) nearly absent, the mesostyle prominent, and the metastyle short. The protocone is isolated, small, and only slightly elongate. A short pli caballin is present. The hypoconal groove is closed, forming a hypoconal fossette. The prefossette has two posterior plications; the postfossette, one well-developed and two weakly developed anterior plications. In the upper molar (TMM 31263-13), the protocone is connected anteriorly to the paraconule via a constricted preprotocrista; the prefossette has three posterior plications; the postfossette, two anterior; and the hypoconal groove or fossette is absent. In -14, the protocone is an elongate oval; the prefossette has three posterior plications; the postfossette, two anterior; and there is no hypoconal groove or fossette. The M3 is weathered and has an isolated protocone, a small pli caballin, and the fossettes appear to be simple.

TABLE 1. Measurements on *Pseudhipparion skinneri* from the Dinero Local Fauna.

Tooth	31263-		APL	BAPL	TRW	PRL	PRW	HT
P2	11	16.3	13.6	13.4	4.5	3.3	26.6	
M3	12	12.5	12.0	11.4	5.3	2.5	30.6	
M1	13	12.8	11.1	12.8	4.5	2.8	27.0	
M1	14	13.1	-	13.3	5.1	3.3	27.6	
Mx	15	11.4	9.2	11.7	-	-	9.5	
		apl	bapl	atw	ptw	mml	entl	h
p	16	14.4	12.0	9.4	9.0	9.1	6.0	34
m	4					9.6		31
m	4a	15.3	-	7.4	7.6	9.5	5.2	32
m	24	18.1	(<15)	5.8	5.4	9.7	5.0	33
m	27	(16)			6.8	8.8	7.2	34
m	28					9.8		34
m3	25	15.9	14.6	6.8	6.3	7.5	5.6	33

The two dp3's have a protostylid and compare well with UF 92965, a dp3 from the Love Bone Bed of Florida. In the lower premolar, there is a protostylid and the hypoflexid (ectoflexid of some previous authors) is short. In the m1or m2, a protostylid is present, the linguaflexid is broad and "U"-shaped, the metaconid and metastylid are widely separated, the hypoflexid penetrates the isthmus, and a pli caballinid is absent; in -24, the hypoflexid is wide and flat at its internal termination; the anterior-posterior length narrows below the crown to approximately 15 mm. In the little worn m3, a protostylid is present, the linguaflexid is very shallow, the metaconid is more elongate than the metastylid, and the termination of the hypoflexid is at the base of the isthmus.

Comparisons—The cheek teeth are smaller than those of the Clarendonian *Nannippus westoni*, *Neohipparion trampasense*, or *Cormohipparion ingenuum*. The early Clarendonian *Calippus regulus* and *Calippus placidus* (both known from Lapara Creek) and the late Clarendonian and early Hemphillian *Calippus elachistus* (Hulbert 1988b) are similar in size to *P. skinneri*. *Calippus* has more broadly connected protocones and simpler fossettes on the upper teeth (Hulbert 1988b). The hypoconal fossette and usually isolated, elongate oval protocone on the upper molars and large mesostylid on the lower molars support assignment of *Pseudhipparion*.

The *Pseudhipparion* from Dinero compares best to *P. skinneri*, which is known elsewhere from the late Clarendonian Merritt Dam Member of the Ash Hollow Formation of Nebraska and Love Bone Bed of Florida, as well as localities from the early Hemphillian of Florida (Webb and Hulbert, 1986). The greatest crown height of an upper tooth from Dinero (TMM 31263-12) is 30.6, compared to a maximum of 43 mm for an unworn upper premolar (UF 59155) from Florida. Other than that, the maximum length of 32 upper cheek

teeth from Florida is 34. The Dinero P2 compares well with three specimens examined in the UF collections from the Love Bone Bed (UF 53622, 53624, and 53626), as well as an illustrated specimen (Webb and Hulbert, 1986, fig. 9 C). In two of those specimens, the protocone is isolated; in two, connected.

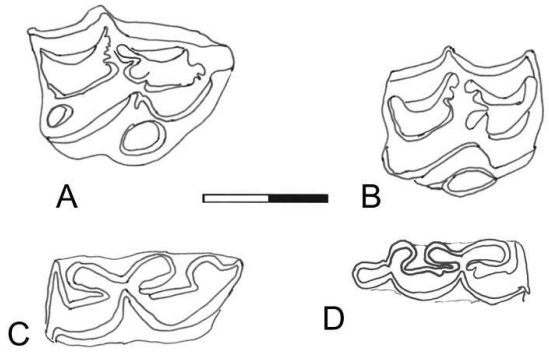

FIGURE 3. *Pseudhipparion skinneri* from Dinero LF, A, TMM 31263-11, right P2; B, -14, right M1; C, -4a, -24, left m1 or m2; D, -25, right m3; scale = 10 mm.

The early Clarendonian Lapara Creek Fauna *Pseudhipparion* is *P. curtivallum*. *Pseudhipparion hessei* is known from the middle Clarendonian MacAdams Ranch Fauna of the Texas Panhandle. The length and width of specimens from Dinero are significantly smaller than those of *P. curtivallum* and *P. hessei*. The late Hemphillian *P. simpsoni* is much higher crowned and if worn to a similar height as the upper teeth from Dinero the fossettes would be reduced or absent (Webb and Hulbert, 1986). The late Barstovian *Pseudhipparion* "early species" from the Bone Valley of Florida (Webb and Hulbert, 1986) is smaller in size and somewhat lower crowned. The crown height of an unworn M3 (UF 23692) is 28.3; of a slightly worn upper molar (UF 63107), 24.9.

Cormohipparion Skinner and MacFadden, 1977
Cormohipparion cf. *ingenuum* (Leidy 1885)
Figure 4, Table 2

Referred Specimens—TMM 31263-17, right P2; -7, right P3 or 4; -2, lingual half of a left M1 or M2; -18, left M1 or M2; -26, left p3 or p4; -19, left m1 or m2; -20, right m1 or m2; -23, right m3.

Description—The P2 has a well-developed and elongate parastyle, the pli caballin is single, the protocone is isolated, the anterior fossette has four posterior plications, the posterior fossette has three anteriorly, and a hypoconal groove is present. The P3 or 4 has a prominent mesostyle and hypoconal groove, a short pli caballin is short, a prefossette that is complexly folded posteriorly, a postfossette that is complexly folded anteriorly, and an oval protocone. In the M1 or 2 (TMM 31263-2), the anterior fossette has 6 posterior plications; the posterior fossette, 7 anterior plications. In -18, the fossettes are weakly plicated, with no pli protoloph or pli hypostyle; the mesostyle is strong; the pli caballin is short; the hypoconal groove shallow. The elongate protocone has a straight lingual border.

The broken lower premolar (-19) has a protostylid, a widely separated, elongate metaconid-metastylid, and a broad, shallow linguaflexid. In the lower molars, -19 has the occlusal surface little worn and complexly folded, and a short pli caballinid, similar to an m1 illustrated by Hulbert (1988c, fig. 10C). The metaconid-metastylid are widely separated. The protostylid begins just below the occlusal surface. On the ventral surface, the enamel lacks plications, the pli caballinid is absent, and the protostylid is well-developed. On the well-worn -20, the hypoflexid is very deep.

TABLE 2. Measurements on *Cormohipparion* cf. *ingenuum* from the Dinero Local Fauna.

Tooth	31263-	APL	BAPL	TRW	PRL	PRW	HT	
P2	17	25.4	-	(17.3)	(6.2)	30		
P	7	19.3	17.2	21.4	8.0	4.8	17	
M	2	20.8						
M	18	17.4	15.7	17.5	7.0	3.8	26	
		apl	bapl	atw	ptw	mml	entl	h
p	26	(19)	-	8.9	7.8	10.9		43
m	19	21.2	18.5	8.8	8.4	10.4	6.7	25.3
m	20	18.4	16.7	12.2	10.7	13.8	7.0	11.6
m	29				9.7	12.7		19
m3	23	21.5	20.5	8.4	7.5	11.0	6.2	28

Discussion and Comparisons—These specimens are referred to *Cormohipparion* because of their size, P2 with a well-developed parastyle (anterostyle of Hulbert); upper cheek teeth with elongate oval protocone and plicated fossettes; and lower cheek teeth with protostylid. Hulbert (1988c) referred the species initially described as *Hippotherium ingenuum* and later as *Nannippus ingenuus* to *Cormohipparion ingenuum*. The type specimen *C. ingenuum* is an upper molar from the early Hemphillian Mixson's Bone Bed of Florida, and the best sample is from the late Clarendonian Love Bone Bed of Florida (Hulbert, 1988c). Of the several hundred specimens from the Lapara Creek Fauna that Forstén (1975) identified as belonging to *N.* cf. *N. ingenuum*, Hulbert (1988c: p:262) stated that only two "appear to represent *C. ingenuum*." The rest he referred of *Nannippus* s.s. Forstén (1975) included two specimens from the Dinero LF (TMM 31263-2 and -7) in *Neohipparion*

occidentale (a species now referred to *Cormohipparion*), but they instead represent *C. ingenuum*, and are described above.

The P2 is in the size range of both *C. ingenuum* and *C. plicatile* (Hulbert, 1988c, table 1). The elongate protocone is not as long as in the similar sized, late Clarendonian *Neohipparion trampasense* (Hulbert, 1987). The simple fossettes seen in -18 and the short pli caballin are similar to some of the specimens illustrated for the latest Clarendonian to early Hemphillian *Nannippus westoni* (Hulbert, 1993) and the early Clarendonian *Neohipparion affine*, which occurs in the Lapara Creek Fauna (Hulbert, 1987). *Nannippus westoni* is not as wide and has a shorter protocone; *Neohipparion affine* is larger and has a more elongate protocone (Hulbert, 1987).

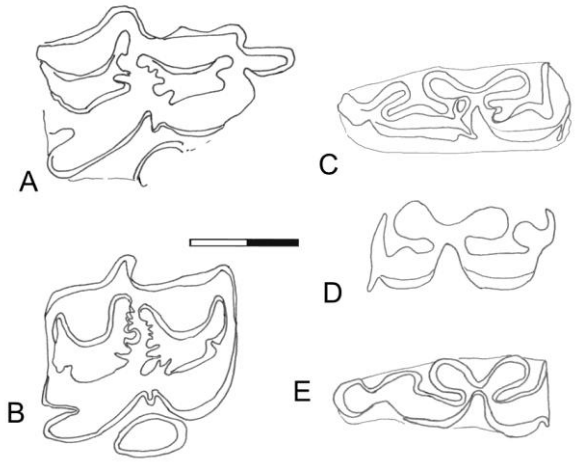

FIGURE 4. *Cormohipparion* cf. *ingenuum* from Dinero LF, A, TMM 31263-17, right P2; B, -7, right P3 or 4; C, D -19, left m1 or m2, occlusal and bottom views; E, -23, right m3; scale = 10 mm.

Calippus Matthew and Stirton, 1930
Calippus cf. *cerasinus* Hulbert, 1988b
Figure 5, Table 3

Referred Specimens—TMM 31263-21, left M1 or 2, -21 broken right upper cheek tooth; -4b, left m1 or 2; -5, right m3.

Description—TMM 31263-21 has a prominent parastyle and mesostyle, the fossettes are vey simple, the protocone is broadly connected anterolabially with the protoselene, there is no hypoconal groove, and the preprotoconal groove is very shallow.

The two lower molars lack protostylids, the metaconid-metastylid are short and close together, the linguaflexids are shallow, and the hypoflexids are deep. -4b is a little worn lower molar (occlusal length is 19.9), but the hypoconulid rapidly diminishes in length (16.4) with wear.

TABLE 3. Measurements on *Calippus* cf. *cerasinus* from the Dinero Local Fauna.

Tooth 31263-		APL	BAPL	TRW	PRL	PRW	HT	
P or M	21	17.3	13.7	18.2	5.8	2.9	19	
M?	22	15.8	12.0				20	
		apl	bapl	atw	ptw	mml	entl	h
m12	4b	16.4	14.0	7.4	7.2	6.5	4.0	42
m3	5	19.5	21.0	7.4		9.2		34

Comparisons—These specimens are assigned to *Calippus* (*Gramohippus*) because of the simple fossettes and absence of protostylids. *Calippus* (*Gramohippus*) *cerasinus* is also known from the latest Clarendonian Merritt Dam Member of the Ash Hollow Formation of Nebraska and the Love Bone Bed of Florida (Hulbert, 1988b). It is larger than the late Barstovian to mid Clarendonian *C.* (*Calippus*) *placidus* and Clarendonian *C.* (*Calippus*) *regulus*, and smaller than the early to mid Clarendonian *C.* (*Gramohippus*) *martini*, all three of which occur in the Lapara Creek Fauna (Hulbert, 1988b). It is much larger than the latest Clarendonian to early Hemphillian *C.* (*Calippus*) *elachistus*. The lower molar (-4b) is similar in size to those of *Pseudhipparion skinneri*, but lacks a protosylid and has a shorter metaconid-metastylid. It can be matched in size by specimens of *C. cerasinus* from the Love Bone Bed (Hulbert, 1988b:table 11).

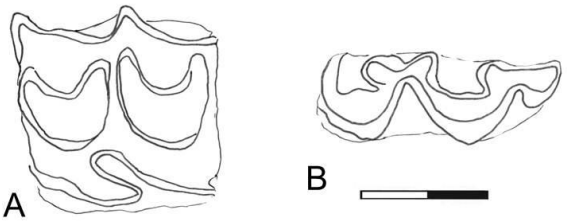

FIGURE 5. *Calippus* cf. *cerasinus* from Dinero LF, A, TMM 31263-21, left M1 or 2; B, -4b, left m1 or m2; scale = 10 mm.

CONCLUSIONS

When Quinn (1955) and Wilson (1956) characterized the biostratigraphy of the Goliad Formation in South Texas, they recognized a well-documented late Miocene (Barstovian) Lapara Creek Fauna and a "late Pliocene" (Hemphillian) Labahia Mission Fauna. The latter consists of two horse teeth (Wilson, 1956), which Baskin (1991) considered non-diagnostic. As noted above, the Lapara Creek Fauna is now assigned to the early Clarendonian. In 2008, Baskin and Hulbert presented a revised biostratigraphy of the Goliad Formation. In addition to the Lapara Creek Fauna, they established a late Clarendonian

Dinero LF and a latest Hemphillian (earliest Pliocene) Lake Corpus Christi LF. The latter is presumed to come from the caprock of the Goliad and includes the reworked fossils described by Baskin (1991). Although the Dinero LF consists of a limited number of specimens, they corroborate a late Clarendonian age for the upper part of the Goliad, just below the caliche cap.

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