Age and Paleontology of the Turin Pit locality, Monona County, Iowa

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ABSTRACT

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The Turin Pit locality (Monona county, Iowa) has been known to paleontologists since 1908, yet the age of the fauna has been unclear. Early paleontologists considered Turin Pit to date to a pre-Illinoian interglacial (the “Aftonian).” Subsequent researchers suggested it dated to the last glaciation. This study provides a partial list of mammals in the Turin Pit fauna, and together with stratigraphic information, uses the known age ranges of taxa to estimate an age for the assemblage. The presence of *Mammuthus*, *Aenocyon*, and *Castoroides* combined with a magnetically-reversed till located stratigraphically above fossil-bearing deposits, suggest the Turin Pit assemblage dates between ~1.3 and 0.773 Ma. The fauna can be assigned to the Irvingtonian North American Land Mammal Age based on *Mammuthus*, *Aenocyon*, *Castoroides*, and *Ondatra zibethicus annectens*. This fossil assemblage provides a rare window into the Quaternary paleontology of Iowa that pre-dates the Illinoian glaciation.

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LIST OF ABBREVIATIONS

NALMA	North American Land Mammal Age
SM	Sanford Museum
ETMNH	East Tennessee State University Museum of Natural History collection
MIS	Marine Isotope Stage
TP	Turin Pit

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CHAPTER 1. INTRODUCTION

Fossil-bearing gravel deposits from the gravel pit in Turin, Monona County, Iowa, have been known to paleontologists for over a century, but conflicting opinions have been expressed regarding the age of these deposits (Calvin and Lees 1909; Hay 1914; Rhodes and Semken 1986). Taxa from these deposits have been identified and discussed in several publications (Calvin and Lees 1909; Shimek 1910; Hay 1914; Dechert 1968; Frankforter 1971; Rhodes and Semken 1986), but have not yet been revised to reflect current taxonomic understanding of fossil groups. The earliest publications that discuss the Turin Pit fauna suggest the assemblage dates to the "Aftonian" (Calvin and Lees 1909; Shimek 1910; Calvin 1911; Hay 1914), a historically recognized early Pleistocene interglacial. The recognition that the assemblage may pre-date the last glacial period illustrates the potential importance of the Turin Pit fauna since most of the fossil deposits within the state are from the Wisconsin glaciation or the subsequent Holocene (Rhodes and Semken 1986).

The potential early age for the mammal assemblage and a preliminary published faunal list (Rhodes and Semken 1986) indicates that the Turin Pit mammal fauna may belong to the Irvingtonian North American Land Mammal Age (NALMA). Irvingtonian faunas are poorly known in the midwestern US (Bell et al. 2004), and Quaternary paleontological sites that predate the last glacial period are rare in Iowa (Rhodes and Semken 1986). The goals of this study are to identify chronologically and ecologically significant mammal specimens from the Turin Pit assemblage and to create an improved estimate for the age of the fauna that is based on known biostratigraphic occurrences of these taxa. These results also have implications for the paleoenvironment of the Turin Pit fauna. Finally, the Turin Pit fauna was instrumental in the biostratigraphic definition of the "Aftonian," therefore, it is also important to discuss the role of the Turin Pit fauna in the historical development of the four-stage, North American Quaternary glacial chronology.

The Aftonian Interglacial

The "Aftonian" as a stratigraphic concept was part of the four glacial and three interglacial period scheme that was historically used to establish chronologies for sedimentary deposits and their inclusive fossils from glaciated regions of North America (Flint 1947). The glacials (G) and interglacials (I) in order from oldest to youngest are the Nebraskan (G), Aftonian (I), Kansan (G), Yarmouthian (I) Illinoian (G), Sangamonian (I) and Wisconsinan (G) (Hay 1914; Leverett 1926; Hansel and McKay 2010). When researchers were developing the glacial and interglacial chronology, more glaciations were proposed than were finally accepted (Leverett 1926). For example, the Iowan was a proposed glaciation occurring between the Illinoian and the Wisconsinan (Leverett 1926). These terms were widely used prior to the 1980s in paleontology to describe the age of fossil localities. However, as modern geochronological methods became more widely used, researchers recognized many more glacials and interglacials than were present in the four-stage glacial chronology (Gibbard et al. 2018).

Turin Pit and other sand and gravel localities from similar stratigraphic contexts throughout western Iowa have been historically attributed to the "Aftonian" (Rhodes and Semken 1986). As defined in the early 20th century, "Aftonian" deposits like those exposed at Turin Pit, are fluvial sand and gravel deposits located stratigraphically between older Nebraskan and younger Kansan glacial tills (Rhodes and Semken 1986). The type section for the "Aftonian" is Afton Junction, IA, which was described before the discovery of the western Iowa deposits (Hay 1914).

The “Aftonian” period was named and described by Chamberlin (1895). These sand and gravel deposits were originally thought to have been deposited after the extensive Kansan glaciation, also described by Chamberlin (1895), and below what at the time was called the Iowan till, which was later synonymized with the Illinoian glaciation (Leverett 1926). The “Aftonian” period was later shifted stratigraphically below the Kansan (Bain 1896; Calvin 1911) and above the Nebraskan glacial till (Bain 1896; Shimek 1910; Hay 1914).

Kay (1924) revisited the Iowa sand and gravel deposits assigned to the “Aftonian.” He believed these deposits did not mark the boundary between the Nebraskan and Kansan; rather, they were sedimentary lenses within one or both of the tills (Kay 1924). Kay’s hypothesis further complicates the age of the Turin Pit gravel deposit, suggesting it could belong to the Kansan glacial, the Nebraskan glacial, or an intermediate interglacial. Regardless, his estimated age of the deposit remained pre-Illinoian (>MIS 6) (Kay 1924). At the same time William C. Alden (1924) argued that the uncertain stratigraphic placement of certain “Aftonian” deposits did not invalidate the “Aftonian” as an interglacial stage. The “Aftonian” as a historical stratigraphic unit is of dubious and uncertain validity. This uncertainty is indicated throughout this thesis by placing the term in quotation marks, i.e., “Aftonian.”

Rhodes and Semken (1986) provided an overview of the history of the “Aftonian” sands and gravels, but they did not believe they were as old as other researchers had claimed. These researchers postulated that the Turin Pit fauna was late Middle Pleistocene or younger based on the fauna present. They also questioned the validity of the correlation of the “Aftonian” beds in western Iowa to the type locality at Afton Junction, and believed that the term “Aftonian” should be dropped in regard to these western Iowa sand and gravel deposits (Rhodes and Semken 1986).

One of the major challenges to studying the historically significant sites and assemblages in paleontology is that sometimes scientific changes happen quickly. The four glacials and three interglacials scheme was used by paleontologists for much of the 20th century, but was suddenly dropped when a modern paleoclimatological chronology became available. While there was probably substantial overlap in time between when the marine isotope chronology was established and the disuse of the glacial terms, stratigraphic efforts generally focused on new localities rather than re-evaluating old ones. This thesis is an effort to re-evaluate one of these older localities that belonged to the “Aftonian”. Revisiting similar sites allows the faunas to be integrated into modern biochronological studies, thus further contributing to our understanding of these Pleistocene glacial and interglacial localities.

Turin Pit is an example of a site that has not been revisited in an attempt to determine its age in many years. This study attempts to address this biochronological gap and update our taxonomic understanding of the Turin site. This includes reconciling the age of the assemblage, given that the traditional four-stage stratigraphic framework for North American glaciations is no longer valid.

Quaternary scientists have generally abandoned the four-stage glacial chronology in favor of absolute-dated Marine Isotope Stages (MIS) (Gibbard et al. 2018). Marine isotope stages can generally be aligned with the last glacial-interglacial-glacial cycle. The Wisconsin glacial period corresponds to MIS 2-4, the Sangamon interglacial period to MIS 5, and the Illinoian glacial period to MIS 6. The majority of in situ paleontological discoveries in western Iowa occur within alluvial settings such as stream beds, or in loess deposits dating to the Last Glacial Maximum (MIS 2) (Rhodes and Semken 1986). Turin Pit is one of few sites within the Loess Hills region of Iowa that predates the last glacial period (MIS 2-4) (Rhodes and Semken 1986).

For the purposes of this thesis, the older four-stage glacial sequence will be used to provide historical context for the "Aftonian" interglacial (defined, in part, by the Turin Pit fauna). However, biochronological analyses of the fauna and discussion of the modern glacial chronology will utilize regional, absolute-dated sedimentary units.

The Irvingtonian North American Land Mammal Age (NALMA)

North American Land Mammal Ages (NALMAs) are biochronological units representing mammalian evolution during distinct sections of geologic time (Woodburne 2004). Each NALMA is defined by a specific group of taxa, and is often correlated to the First Appearance Dates (FADs) or Last Appearance Dates (LADs) of these taxa. They can be used to help describe fossil localities in terms of faunal communities and provide general constraints on the age of an assemblage. NALMAs are not tied to exact dates, but are closely correlated with the appearance or disappearance of species so they can be associated with an approximate age. The age of a NALMA will change if the FAD or LAD of key taxa change.

The Irvingtonian NALMA was originally defined by Savage (1951) based on fauna from Irvington, California. Savage used the absence of *Bison* and the presence of earlier but related forms of Rancholabrean and Recent taxa, to define the Irvingtonian NALMA. However, since it is not recommended to use the absence of a taxon to define a NALMA, first occurrence dates of additional taxa have been used to define the early boundary of the Irvingtonian. The Irvingtonian is now defined based on the first appearance of *Mammuthus* in North America below the 55°N latitude which currently coincides with an age of 1.3-1.4 Ma (Bell et al. 2004). In defining the Irvingtonian, Bell et al. (2004) also identified many of the taxa that are found within the Irvingtonian (Table 1).

Table 1 Taxa found within the Irvingtonian NALMA (updated from Bell et al. 2004). For this study, *Aenocyon* (=*Canis*) *armbrusteri*. The reasons for this change are discussed below.

Taxa appearing earlier and persisting into Irvingtonian	**Taxa limited to Irvingtonian**	**Taxa appearing in Irvingtonian and persisting after**
Glyptotherium	*Microtus llanensis*	*Didelphis*
Blarina	*Microtus meadensis*	*Brachylagus idahoensis*
Sylvilagus	*Microtus paroperarius*	*Sylvilagus palustris*
Miracinonyx inexpectatus	*Canis* armbrusteri*	*Clethrionomys*
Smilodon gracilis	*Tetrameryx irvingtonensis*	*Lemmiscus curtatus*
Arctodus pristinus		*Ondatra zibethicus*
Ursus		*Marmota flaviventris*
Mammut americanum		*Marmota monax*
Nothrotheriops		*Cynomys gunnisoni*
Paramylodon harlani		*Cynomys ludocivianus*
Holmesina		*Panthera onca*
Lepus		*Smilodon populator*
Allophaiomys pliocaenicus		*Mustela erminea*
Microtus (5 closed triangles on m1)		*Brachyprotoma*
Mictomys kansasensis/meltoni		*Conepatus*
Neofiber		*Canis latrans*
Ondatra zibethicus annectens		*Canis lupus*
Phenacomys		*Arctodus simus*
Synaptomys		*Euceratherium*

Sciurus		*Oreamnos*
Canis edwardii		*Mammuthus*
Lontra canadensis		
Homotherium		
Platygonus vetus		

The Turin Pit locality, Monona County, IA

Paleontological localities that produce Pleistocene-aged mammalian fossils are common throughout Iowa and the Great Plains. Fossil-bearing sand and gravel deposits in the small town of Turin (Monona Co., IA) have been known to paleontologists since at least 1909 (Calvin and Lees 1909) (Table 2). Initially, Quaternary fossils were discovered in deposits of a small aggregate pit (called "Elliott" pit). Subsequent nearby mining operations were much more extensive. This later operation was named after the town of Turin, and was the focus of activities during the period when fossils were being collected by volunteers from the Sanford Museum. Approximately 100 meters separates the Turin and Elliot pits (Dechert 1968). Both pits access the same sand and gravel deposit. As Turin operations expanded, it is likely that they consumed the earlier Elliot pit (Rhodes and Semken 1986). The two pits are often considered synonymous and fossils from either pit make up what has been called the Turin local fauna (Frankforter 1971). Despite early collecting from the site and its long history, few papers have been published that discuss the mammalian fauna in detail (Table 2), and there have been conflicting estimates of the age of the site.

Table 2 Previously published faunal lists of the Turin Pit locality. Each column presents those taxa identified by a researcher from Turin or Elliott Pit sand and gravel deposits. Rows represent taxa that may have been identified from the same or similar material and could represent how the identifications have changed over time as different researchers have re-evaluated the material. An * indicates taxonomic uncertainty on the part of the original author.

Calvin and Lees 1909	**Calvin 1911**	**Hay 1914**	**Dechert 1968**	**Rhodes and Semken 1986**
Mammut americanum	*Mastodon americanus*	*Mammut americanum*	*Mammut americanum*	*Mammut americanum*
Elephas columbi	*Elephas columbi*	*Elephas columbi*	*Mammuthus columbi*	*Mammuthus* spp.
Elephas imperator	*Elephas imperator**	*Elephas imperator*	*Mammuthus imperator**	
	*Elephas primigenius**		*Mammuthus* sp.	
Equus scotti	*Equus scotti*		*Equus scotti*	*Equus* spp.
	*Equus pacificus**			
Equus complicatus	*Equus complicatus*	*Equus complicatus*		
		Equus niobrarensis	*Equus niobrarensis**	
		Equus excelsus		
	Hipparion			
*Camelus**	Camelidae		*Camelops kansanus*	*Camelops* spp.
			Camelops huerfanensis	
			Camelops sp.	
*Cervus**	cf. *Odocoileus virginianus**			*Odocoileus* sp.*
				Rangifer sp.
			Cervalces sp.	
				Platygonus sp.

Undetermined ruminant (*Ovibos*?)			*Euceratherium (Aftonius) calvini**	*“Aftonius calvini” (Euceratherium collinum)*
Mylodon				*Glossotherium harlani*
	Megalonyx jeffersonii	*Megalonyx*	*Megalonyx jeffersonii*	*Megalonyx jeffersonii*
Ursus	Ursidae			*Ursus americanus*
				Canis lupus
				Canis latrans
				Vulpes sp.
				Procyon sp.
				Taxidea taxus
			Felidae	*Panthera* sp.
				Castor canadensis
	Castoroides	*Castoroides ohioensis*	*Castoroides ohioensis*	*Castoroides ohioensis*
			Geomys	
				Didelphis sp.

Shimek (1908) was the first to examine “Aftonian” deposits in western Iowa. Calvin and Lees (1909) first mention the Turin Pit locality (as Elliot Pit) in the Report of the Iowa Geological Survey. Early investigators noted that the sand and gravel deposits at Turin overlie a dark blue clay unit that contained boulders. The latter was interpreted as a till of the Nebraskan glacial stage (Calvin and Lees 1909; Shimek 1910). Shimek (1910) describes the Turin sand and gravel unit as being typical of “Aftonian” crossbedding, with gravel underlying and occasionally interbedded with sand, and streaked with iron and manganese dioxide. More evidence of the site being an “Aftonian” bed is provided by its stratigraphic position below a Kansan till, Loveland

and Peoria loess deposits. These deposits are typical for the region and supported an "Aftonian" age according to Shimek (1910). They also support a pre-Illinoian (MIS 6) age on the basis of our current understanding of the regional Pleistocene stratigraphy (Roy et al., 2004).

Calvin and Lees (1909) were the first to define the "Aftonian" fauna found within the sand and gravel deposits of western Iowa and list a number of taxa found at these sites (Table 2). Taxa identified by these authors include: *Mammut americanum*, *Elephas imperator*, *Elephas columbi*, *Equus scotti*, *Equus complicatus*, *Camelus*?, *Cervus*?, *Mylodon*, *Ursus*, and an undetermined ruminant probably *Ovibos* (Calvin and Lees 1909). The 1909 Iowa Geological Survey is, therefore, the first publication that provides a preliminary faunal list for the Turin locality.

Calvin (1911) revised his initial faunal list as new material was found. He expanded the list of "Aftonian" fauna to include *Elephas primigenius* (found only at Denison pit, Crawford county), *Equus pacificus*? (only one specimen, Turin Pit), *Hipparion* (found at Afton Junction, Union county), a cervid that is similar to *Odocoileus virginianus*, *Megalonyx jeffersonii*, and *Castoroides* (Table 2, Calvin 1911). Calvin (1911) also made alterations to his original identifications, changing *Mammut americanum* to *Mastodon americanus*, changing *Camelus* to taxonomically uncertain Camelidae, and revising *Ursus* to uncertain bear material (Ursidae, Table 2). There is no follow-up discussion of *Cervus* or the unidentified ruminant (possibly *Ovibos*) in the updated fauna description (Calvin 1911).

Calvin and Lees (1909) and Calvin (1911) discussed the taxa identified from the "Aftonian" beds as a whole, but later publications discussed the taxa found specifically at Turin. Hay (1914) reported *Mammut americanum*, *Elephas columbi*, *Elephas imperator*, *Equus excelsus*, *E. niobrarensis*, *E. complicatus*, *Megalonyx*, and *Castoroides ohioensis* (Table 2). This is the first faunal list reported that only includes specimens from Turin and not from the entirety of the western Iowa "Aftonian" sand and gravel localities.

The most comprehensive review of "Aftonian" faunas from Harrison and Monona counties was performed by Dechert (1968), who reported taxa from all known "Aftonian" localities. Dechert (1968) was also the first investigator to compare taxonomic patterns between individual sites. Dechert (1968) added *Cervalces* sp., Felidae, and *Geomys* to the list of mammals from the Turin Pit locality. Furthermore, he only mentions the horses *E. scotti* and *E. niobrarensis,* and does not include the previously reported small cervid or the ursid (Dechert 1968). Camelidae was refined to *Camelops kansanus*, *Camelops huerfanensis*, and *Camelops* sp. (Dechert 1968). The undetermined ruminant previously suggested to be *Ovibos* was identified as *Euceratherium* (*Aftonius*) *calvini* (Dechert 1968). *Castoroides* was identified to the species level of *Castoroides ohioensis* (Dechert 1968). Dechert (1968) also provides a good example of how names change through time. *Mastodon americanus* became *Mammut americanum* (Table 2).

Rhodes and Semken (1986) reviewed the paleoecology and biostratigraphy of the Loess Hills region of western Iowa and provide a composite faunal list of the Turin assemblage (from both Elliot and Turin Pit) based on all of the previous research (Table 2). Differences between this faunal list and previous publications include *Mammuthus* species being lumped into *Mammuthus* spp., *Equus* species being combined into *Equus* spp., and all *Camelops* species considered *Camelops* spp. (Rhodes and Semken 1986). This faunal list also added the new taxa *Odocoileus* sp., *Rangifer* sp., *Platygonus* sp., *Glossotherium harlani*, *Ursus americanus*, *Canis lupus*, *Canis latrans*, *Vulpes* sp., *Procyon* sp., *Taxidea taxus*, *Castor canadensis*, and *Didelphis* sp. (Rhodes and Semken 1986). Rhodes and Semken (1986) also refined Felidae to *Panthera* sp. (Table 2). These additions to the faunal list were likely from newly published (McDonald and

Anderson 1983) and unpublished sources (Frankforter 1971; Frankforter n.d. in Rhodes and Semken 1986). Rhodes and Semken (1986) proposed that “Aftonian” sands and gravels from western Iowa were not early Pleistocene in age (i.e., late Blancan NALMA) but possibly belonged to the late Irvingtonian or early Rancholabrean NALMAs. This is a very different idea presented for the age of Turin compared to the original publications about the western Iowa sands and gravels.

This thesis project is designed to review much of the Turin material to provide a partial faunal list using modern paleontological techniques and a modern understanding of taxonomy. Other goals of this project include determining an age for Turin Pit based on the taxa that are present and stratigraphic evidence, and making inferences about the environment based on what is known about the habitat preferences of the identified taxa. The importance of this project is to re-evaluate the Turin Pit locality so that what we learn from it can be added to our current understanding of paleontology for the region.

CHAPTER 2. MATERIALS

The Turin Pit locality is located at the eastern edge of the Missouri River valley in Monona County, Iowa in the Loess Hills, latitude 42° 1′ 15″N, longitude 95° 58′ 3″W. The Turin Pit locality is capped by Peoria loess (McDonald and Anderson 1983) that dates to the Last Glacial Maximum (LGM). This loess overlies a colluvium which comprises both a Pre-Wisconsin glacial till and the Loveland loess (McDonald and Anderson 1983). Paleomagnetic data can help with understanding the age of this locality. Roy et al. (2004) examined sedimentology and paleomagnetism of Quaternary tills across the North-Central US, including the gravel pit at Turin, IA and several other localities within the Missouri River valley. The till unit in the colluvium at Turin had reversed weak remnant magnetism (Roy et al. 2004). The lithology and mineral content of this deposit is consistent with a regional group of magnetically reversed glacial tills ("R1" in Roy et al. 2004) that occured during the later portion of the Matuyama Chron (Roy et al. 2004). Roy et al. (2004) suggested that tills within this group were deposited between 1.3 and 0.8 Ma. Below the reversed till unit is a sand and gravel deposit (McDonald and Anderson 1983) which is the focus of this paper and the layer from which the Turin fauna was collected. When referring to "Turin" or the "Turin Pit locality" in this thesis, I will only be referencing the fossil-bearing sand and gravel deposits.

All fossil material included in this study is from the Turin Pit locality. This material was surface collected in the 1960s through the 1970s by volunteers from the Sanford Museum (Cherokee, Iowa), under the supervision of W. D. Frankforter and later by D. C. Anderson. Many of the best-preserved specimens from Turin Pit are on display at the Sanford Museum, where the collection is permanently curated. Specimens collected from Elliot pit prior to the 1960s are housed in the University of Iowa Paleontological Repository (Iowa City, IA) and are not part of this study. Turin specimens from the Sanford Museum are cataloged with a “Z” number (xx-xx-Z). Some of the specimens have not been given official catalog numbers, so they will be referred to as “TP-XXX” with TP representing Turin Pit. A large sample of the Sanford specimens was temporarily loaned to East Tennessee State University for analysis. I also traveled to the Sanford Museum in Cherokee IA, to examine specimens on display and in the collection.

CHAPTER 3. METHODS

Taxonomic identification of mammalian material from Turin was accomplished through comparisons to extinct and extant specimens and the use of published descriptions of species and genera. Many of the specimens found at Turin could not be identified beyond "bone fragment", so only those that could be identified to family, genus, or species were included in this study. In some cases specimens could only be identified to higher taxonomic levels, but the identification of these groups added to the faunal diversity. The majority of taxa were identified to the genus level due to a lack of preserved characters that would allow a species-level identification. These are denoted as "genus sp." indicating that they are one of the already established members of the genus, but which species cannot be determined. It is possible that some of these specimens (where noted) are new species or extend records of known species into the Midwest. In some cases, it was possible to advance identifications to the species level.

Comparative material came from the East Tennessee State University of Natural History zoological collections (ETMNH-Z) and published sources. All photos were taken on an iPhone 12. Photo editing and figure construction occurred in Inkscape 1.2.2. Measurements of specimens follow Von den Driesch (1976) when applicable. Additional measurements and anatomical nomenclature for Canidae are from Nowak (1979) and Tedford et al. (2009). Measurements of modern *Vulpes vulpes*, *V. lagopus*, and *Urocyon cinereoargenteus* used for comparative purposes with TP-005 were collected from specimens in the ETMNH-Z collection. Additional measurements on SM 167-58-Z (*Panthera* cf. *P. onca*) are from Seymour (1983). The timeline figure was created in Inkscape and based on the timeline from timescalecreator.org and published age ranges for the taxa that were included. Scatter plots were made using Microsoft Excel.

CHAPTER 4. RESULTS

Systematic Paleontology

Class MAMMALIA Linnaeus, 1758

Order CARNIVORA Bowditch, 1821

Family CANIDAE Fischer von Waldheim, 1817

Subfamily CANINAE Fischer von Waldheim 1817

Genus *AENOCYON* sp. Merriam, 1918

Referred Specimens – SM 15-74-Z

Locality – Turin Pit, IA

Description – Left dentary with canine, p2, p3, and p4, alveoli of i1-i3, p1, m1-3 (Fig. 1). The p2 and p3 lack posterior accessory cusps, but the p4 contains a secondary cusp and a third cusp just anterior to the posterior cingulum where the tooth is broken. The alveolus of the m1 is large, but may be altered by pathology. The ascending ramus is noticeably broad antero-posteriorly.

Fig. 1 Left dentary of *Aenocyon* sp. (SM 15-74-Z) from Turin with c1, p2-p4 (m1-m3 are missing) in lateral (top) and occlusal (bottom) view.

Remarks – The left dentary (SM 15-74-Z) was identified as a canid based on the dental formula of four premolars and three molars, along with enlarged canid-like canines. The remaining teeth of the dentary, p2-p3, have the single cusp and bladelike shape of Canidae. The horizontal ramus is similar in width, depth, and length to *Canis lupus*. However, the coronoid process is antero-posteriorly wider and more robust than in modern *C. lupus*. The width and length of the alveolus for the m1 is larger than *C. lupus.* A pathology of the m1 alveolus is expressed as excessive bone growth deep in the jaw and does not affect the accuracy of alveolar width or length. The most diagnostic character is the presence of both a second and third cusp on the p4, with the third cusp being separate from the posteromedial cingulum. Although the posterior portion of the p4 is broken, this small third cusp remains visible above the cingular shelf. The presence of this third cusp on the p4 is the most important character that distinguishes *Canis armbrusteri* from *C. lupus* (Tedford et al. 2009; Nowak 1979). This character is present in both *C. armbrusteri* and *Aenocyon dirus*, and the two species also share other morphological traits (Tedford et al. 2009).

Phylogenetic studies have placed *C. armbrusteri* as a potential ancestor/precursor to *A. dirus* (Wang and Tedford 2008; Tedford et al. 2009). Recent molecular work assigned the dire wolf to the genus *Aenocyon* (Perri et al. 2021). Furthermore, *A.dirus* and *C. armbrusteri* are morphologically very similar (Tedford et al. 2009). It follows that *Canis armbrusteri* should also be part of the genus *Aenocyon*; it will be referred to as *Aenocyon armbrusteri* in this study.

On the basis of the p4 morphology, SM 15-74-Z is identified as a large wolf belonging to the genus *Aenocyon*. When measurements of the Turin Pit dentary are compared to other published specimens, the Turin specimen groups with other *A. armbrusteri* (Fig. 2, Fig. 3, Fig. 4). Some *A. dirus* specimens also plot with the *A. armbrusteri* group. This could mean a number of different things; that these measurements are not diagnostic at the species level, that some *A. dirus* specimens are misidentified, or that there is variability in the size of *A. dirus* across their range. At this time, it is difficult to distinguish between these scenarios.

Other morphological differences between *A. dirus* and *A. armbrusteri* include: *A. dirus* is noticeably larger in body size, *A. armbrusteri* has a narrower skull, and *A. armbrusteri* has a smaller m1, but with a more inflated m1 talonid (Nowak 1979). Unfortunately, these characters are lacking in the Turin Pit canid specimen.

This specimen is assigned to the genus *Aenocyon* based on morphology, but at this time a species identification cannot be determined.

The Turin jaw was also compared to published measurements of *Canis lepophagus* and *Canis edwardii* (Nowak 1979; Tedford et al. 2009). These taxa are more gracile and smaller than the Turin specimen. Their teeth are not as robust and are proportionally taller than Turin premolars when compared to their width. *C. lepophagus* and *C. edwardii* are more similar to the modern coyote *Canis latrans* in size and morphology than they are to wolf-like canids such as *A. dirus* and *A. armbrusteri* (Tedford et al. 2009).

A large canid found in Texas was originally thought to be a *Protocyon* (Kurten and Andersen 1980), but has been reassessed as *Xenocyon texanus* (Tedford et al. 2009). There are some similarities between *X. texanus* and the Turin specimen, such as few or no posterior cusps on p2 and p3, and a second posterior cusp separate from the cingulum on p4. However, the premolars of *X. texanus* are proportionally taller than those in the Turin specimen. *X. texanus* also has a more robust canine and deeper jaw than the Turin specimen.

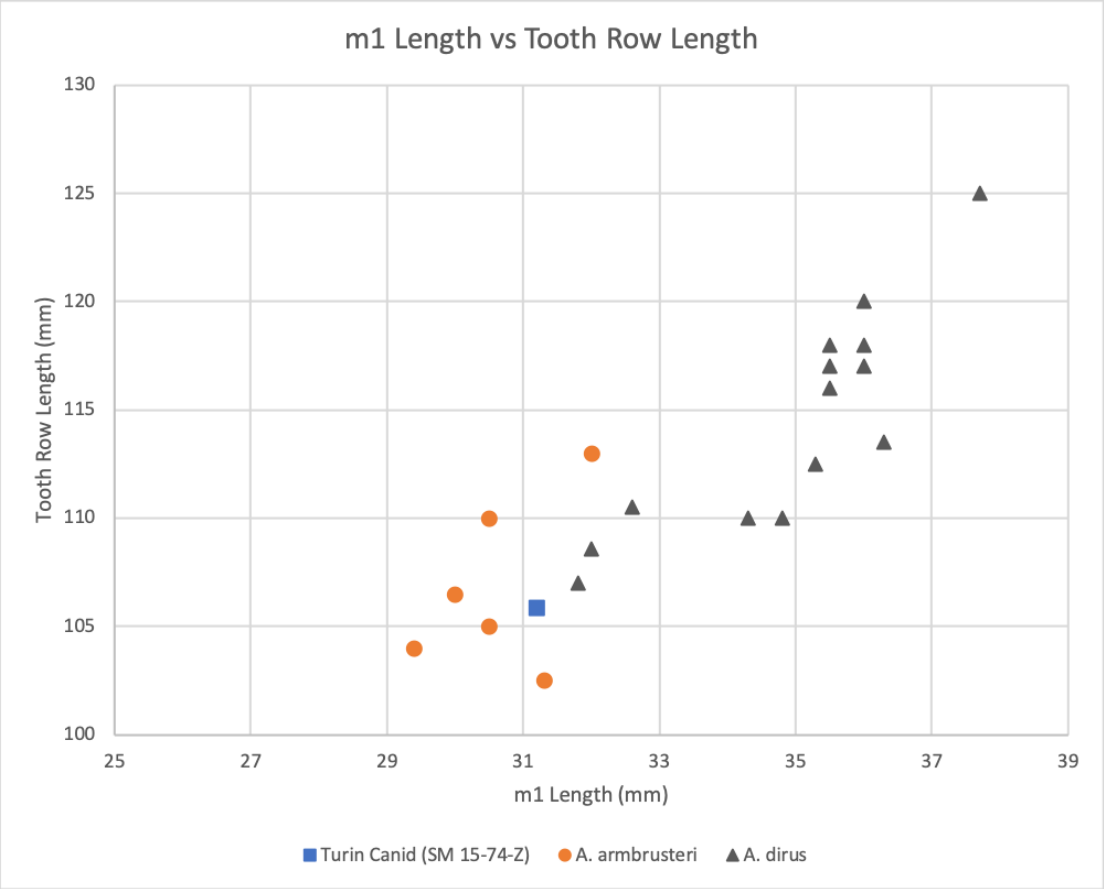

Fig. 2 Comparison of m1 length and tooth row length. The Turin specimen is represented in a blue square, *A. armbrusteri* specimens are represented in orange circles, and *A. dirus* specimens are represented in gray triangles. *A. armbrusteri* and *A. dirus* data are from Nowak (1979).

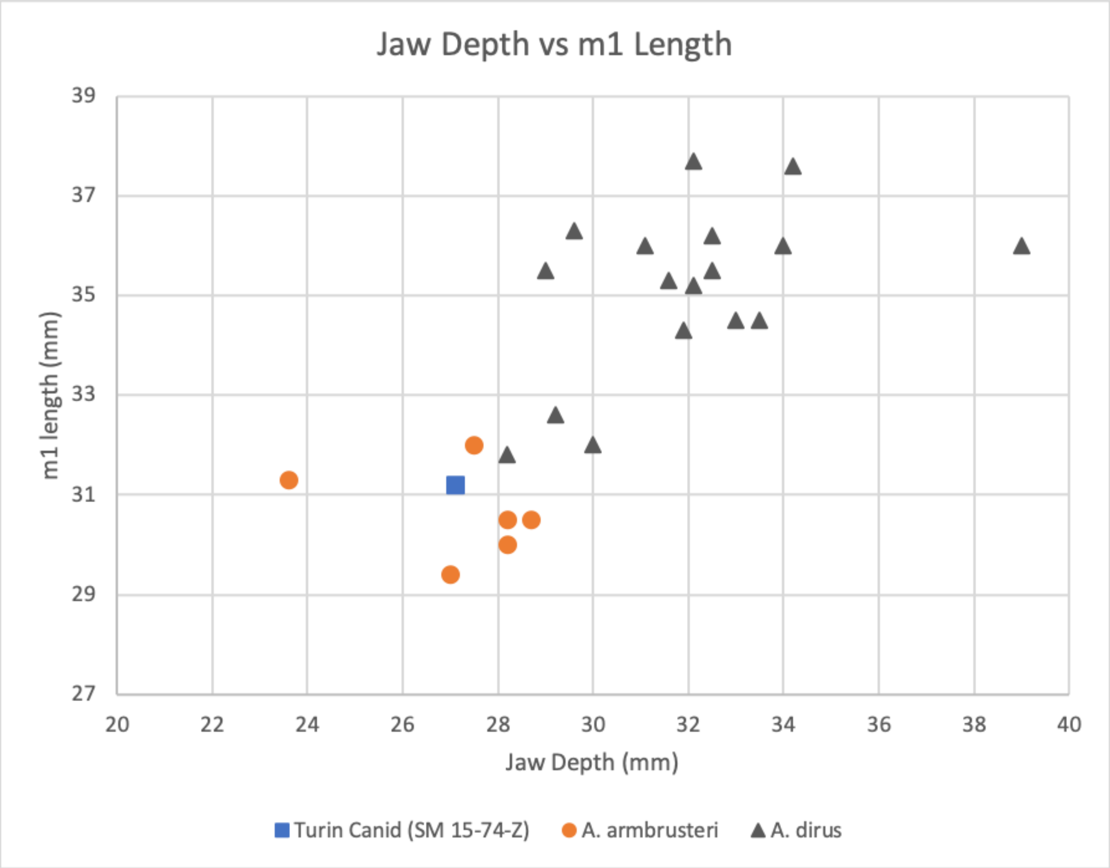

Fig. 3 Comparison of jaw depth and m1 length. The Turin specimen is represented in a blue square, *A. armbrusteri* specimens are represented in orange circles, and *A. dirus* specimens are represented in gray triangles. *A. armbrusteri* and *A. dirus* data are from Nowak (1979).

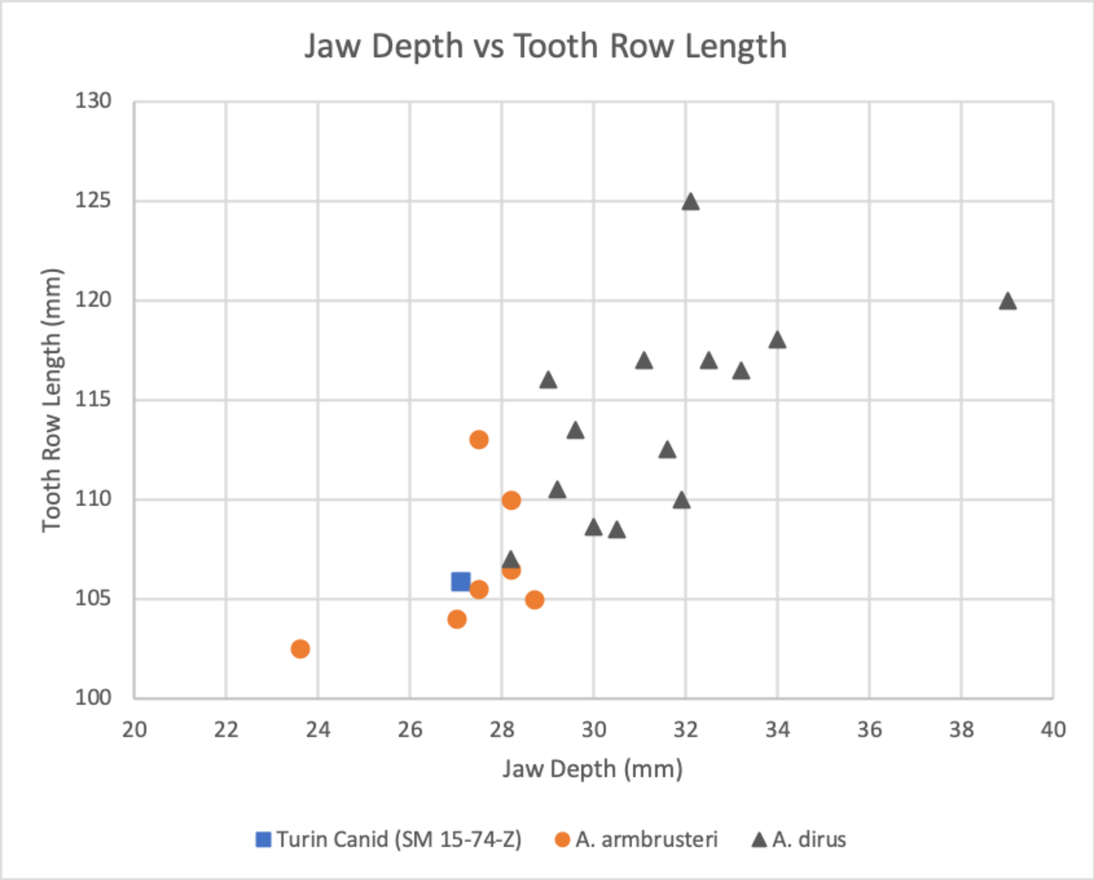

Fig. 4 Comparison of jaw depth and tooth row length. The Turin specimen is represented in a blue square, *A. armbrusteri* specimens are represented in orange circles, and *A. dirus* specimens are represented in gray triangles. *A. armbrusteri* and *A. dirus* data are from Nowak (1979).

Subfamily Caninae Indet.

Referred Specimens – TP-005 (Upper left P4)

Locality – Turin Pit, IA

Description – Upper left P4 which is small (11.8 mm in length) and blade-like with a small protoconid protruding from the lingual side (Fig. 5).

Fig. 5 Upper left P4 (TP-005) in labial (top) and occlusal (bottom) view.

Remarks – There is no parastyle present on this specimen as in felid upper P4s, and it has a true carnassial notch which is typically lost in mustelids. This P4 belongs to a canid and specifically a member of Caninae due to the reduced protocone that is not found in members of Borophaginae (Wang et al. 1999). Many members of Caninae have a reduced protocone such as *Vulpes kernensis*, *Canis lepophagus*, *Canis feneus*, and *Aenocyon*, but all members of the tribe Canini that have similar morphology are much larger than this specimen (Tedford et al. 2009).

In comparing the specimen to modern North American foxes, both *Vulpes* and *Urocyon* are similar in size and morphology to the Turin specimen. The Turin specimen groups more closely with members of *Vulpes* but remains intermediate between the two groups (Fig. 6). It is unlikely that this specimen belongs to the genus *Urocyon* because members of this genus often have an aterolabial cingulum on their P4 (often with a small parastyle), which is lacking in this specimen (Tedford et al. 2009). This specimen is similar in size and morphology to both extant and extinct members of the genus *Vulpes* (Tedford et al. 2009). There is a gap in the fossil record for *Vulpes* during the Irvingtonian (Tedford et al. 2009). Tedford et al. (2009) acknowledge the few Irvingtonian specimens that are similar to *Vulpes* and attribute them to *Vulpes* sp. cf. *V. velox*, but there are no good characters on the available material from Turin to fully identify this specimen to the species level. Detailed comparisons to other species of *Vulpes* (e.g. *V. velox*, *V. macrotis*) could be conducted in future research to attempt to resolve this identification further.

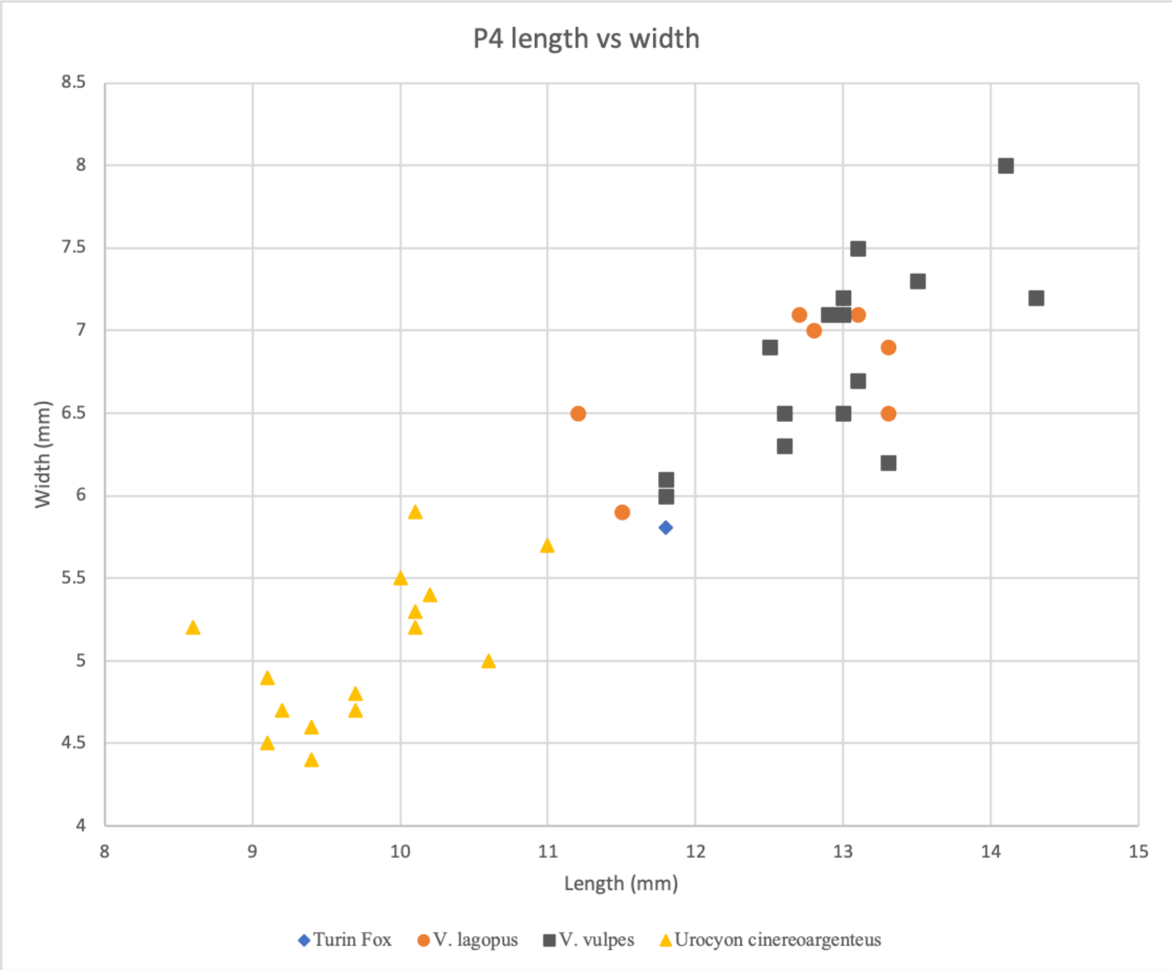

Fig. 6 Comparison of length and width of the upper P4. The Turin specimen is in blue, Arctic fox (*V. lagopus*) is in orange, Red fox (*Vulpes vulpes*) is in grey, and the Gray fox (*Urocyon cinereoargenteus*) is in yellow.

Family FELIDAE Gray, 1821

Genus *PANTHERA* Oken, 1816

PANTHERA cf. *P. ONCA*

Referred Specimens – SM 167-58-Z

Locality – Turin Pit, IA

Description – Right maxilla containing alveoli and fragments of P2, P3, and P4 (Fig. 7). Crown morphology is not preserved, but the teeth are large and uncrowded.

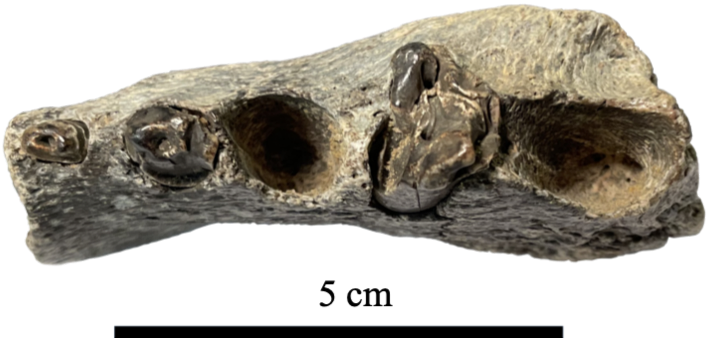

Fig. 7 Right partial maxilla of *Panthera* cf. *P. onca* from the Turin locality with broken teeth and remnants of P2-P3. The specimen is in occlusal view.

Remarks – Despite the broken teeth, the shape of the specimen and the dental formula indicates this is a felid (Orsini and Hennet, 1992). The teeth of this specimen are large and uncrowded. This specimen is larger than documented for *Miracinonyx* or *Puma* (Van Valkenburgh et al. 1990) and does not have a shortened face with crowded dentition like *Miracinonyx* (Adams 1979). The characters that are present in this specimen are shared with modern *Panthera onca,* however, the Turin specimen is larger, which is consistent with Pleistocene jaguars in North America (Seymour 1993).

Other large cats of the Pleistocene, members of Machairodontinae, typically do not have an upper P2 and have a much longer more blade-like P4 with an extended parastyle on the anterior portion of the tooth (Berta and Galiano 1983).

It is more challenging to identify this specimen to a species within the genus *Panthera.* Since this is a Pleistocene North American locality, there are three potential candidates, *Panthera onca*, *Panthera atrox,* and *Panthera spelaea*. These species differ greatly in size, *P. atrox* and *P. spelaea* are larger than the Pleistocene form of *P. onca* (Kurten and Anderson 1980; Seymour 1993). The size of the Turin specimen's P3 and P4 is most similar to Pleistocene jaguars (Fig. 8, Fig. 9). Size is the only character displayed by this specimen that can be used to distinguish between the three species, therefore this specimen is identified as *Panthera* cf. *P. onca* to indicate a species level identification will not be reached, but that this specimen is most similar to North American Pleistocene jaguars.

Turin is outside of the modern geographic range of jaguars, but Pleistocene *P. onca* extended further north during the Rancholabrean and Irvingtonian (Kurten and Anderson 1980). Pre-Wisconsin jaguars lived as far north as Washington state (Kurten and Anderson 1980). *Panthera atrox* was distributed throughout the southern half of North America, and *Panthera spelaea* is known from Eurasia and Beringia, not ranging very far south into North America (Barnett et al. 2016).

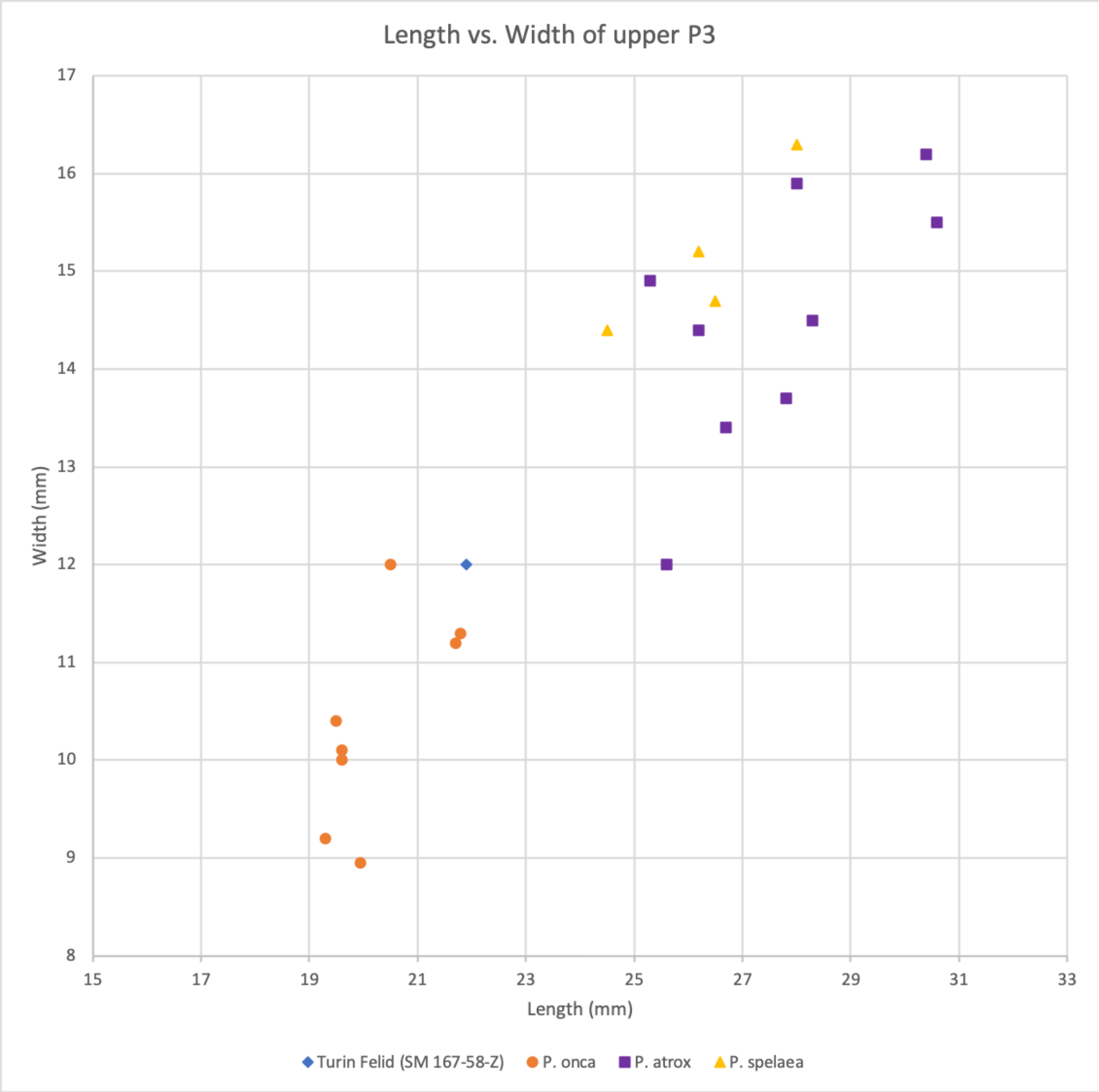

Fig. 8 Comparison of Length and Width of the upper P3. The Turin specimen is represented in a blue diamond, Pleistocene *P. onca* is represented in orange circles, Pleistocene *P. atrox* is represented in purple squares, and Pleistocene *P. spelaea* is represented in yellow triangles. Data for *P. atrox* are from Merriam and Stock (1932); Pleistocene *P. onca* are from Guilday and McGinnis (1972), Kurten (1965), Simpson (1941), and Slaughter (1966); *P. spelaea* are from Sotnikova and Nikolskiy (2006).

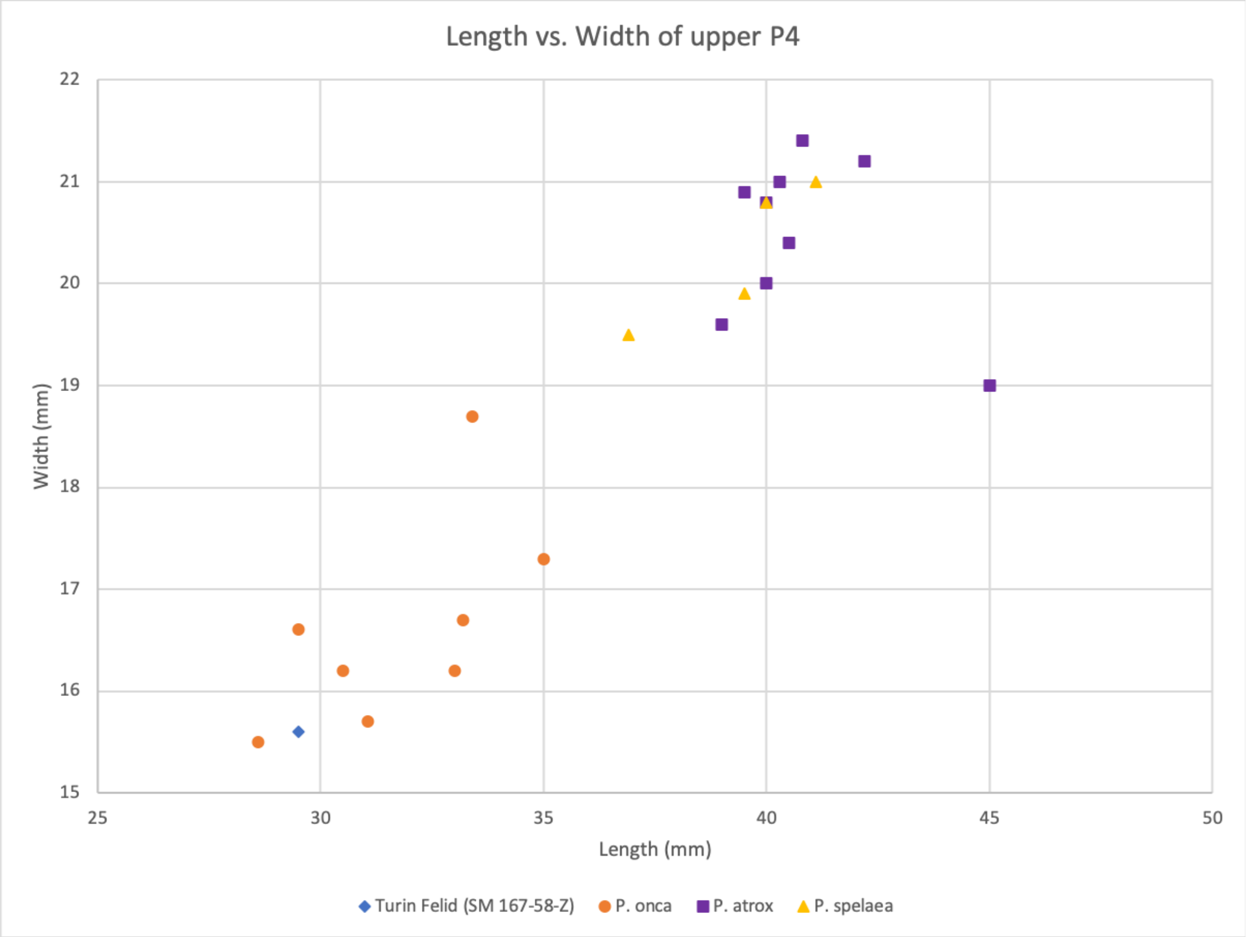

Fig. 9 Comparison of Length and Width of the upper P4. The Turin specimen is represented in a blue diamond, Pleistocene *P. onca* is represented in orange circles, Pleistocene *P. atrox* is represented in purple squares, and Pleistocene *P. spelaea* is represented in yellow triangles. Data for *P. atrox* are from Merriam and Stock (1932); Pleistocene *P. onca* are from Guilday and McGinnis (1972), Kurten (1965), and Slaughter (1966); *P. spelaea* are from Sotnikova and Nikolskiy (2006).

Family MUSTELIDAE Indet. Fischer von Waldheim, 1817

Referred Specimens – SM 56-75-Z

Locality – Turin Pit, IA

Description– Left dentary, broken anteriorly and posteriorly, preserved from the posterior portion of canine alveolus to the m2 and beginning of masseteric fossa; alveoli of p4-m2; may have had other premolars, but these were lost in life such that the alveoli were resorbed (Fig. 10). The p4 appears to be double rooted, the m1 triple rooted, and the m2 single rooted.

Fig. 10 Mustelidae indeterminate left dentary (SM 56-75-Z) from Turin (bottom) compared to modern *Lontra canadensis* (ETMNH-Z 18250) (top).

Remarks – Size, proportion, and dental formula suggest a small carnivoran of the family Mustelidae. Length of the tooth row, measured from posterior-most root of c1 to posterior-most root of m2 is 38.8 mm. The height of the horizontal ramus behind the m1 is unmeasurable due to breakage, so the height of the mandible was measured between the alveoli of the p4 and m1 (12 mm). This specimen is larger than small mustelids, such as mustelines, and members of Mephitidae. The specimen does not have the dental formula of a procyonid such as *Procyon lotor*. The most likely candidates for the identity of this specimen are larger mustelids such as *Lontra, Pekania, Gulo,* or *Taxidea*. All *Taxidea* specimens from the ETMNH zoological collections (N=10) have a double-rooted m2, while the Turin specimen does not. The specimen is similar to *Lontra* in terms of alveoli spacing, number of roots on teeth, and overall size and proportions. All specimens of *Lontra canadensis* from the ETMNH-Z collection that had visible roots (N=19) also had a small third root on the m1 similar to the Turin specimen. This trait was not observed in specimens of *Pekania* or *Gulo* from the ETMNH-Z collection. While this specimen is weathered, broken, and missing teeth, there are key characters that are identifiable to the family Mustelidae. This specimen shares an interesting and potentially diagnostic character with *Lontra canadensis,* but further research into this character is necessary to take the identification of this specimen further. *Lontra canadensis* first appears in North America during the latest Blancan or Irvintonian, ~1.8 Ma (Kurten and Anderson 1980).

Subfamily TAXIDIINAE Indet. Pocock, 1920

Referred Specimens – SM 69-73-Z

Locality – Turin Pit, IA

Description – Edentulous left dentary broken across the p3 alveoli and the coronoid process (Fig. 11). p4, m1, and m2 all double rooted.

Fig. 11 Taxidiine dentary (SM 69-73-Z) from Turin in occlusal view.

Remarks – The spacing and number of alveoli indicate that this specimen is a mustelid. Its relatively large size is inconsistent with smaller members of the family and Mephitidae. As noted above, when comparing the otter specimen to *Taxidea* specimens in the ETMNH zoological collection, all *Taxidea* specimens had a double rooted m2, and this character is visible on Turin specimen SM 69-73-Z. This trait was not observed in any of the specimens of *Pekania* or *Gulo* from the ETMNH-Z collection. *Taxidea* and *Pliotaxidea* both can exhibit a double rooted m2 (Baskin 1998). This specimen is identified as Taxidiinae indeterminate.

Order RODENTIA Bowditch, 1821

Family CASTORIDAE Gray, 1821

Genus *CASTOROIDES* Foster, 1838

CASTOROIDES sp.

Referred Specimens – SM 66-56-Z

Locality – Turin Pit, IA

Description – Nearly complete incisor with moderate curvature, enamel ridges and grooves run the full length of the tooth on the anterior and lateral surfaces (Fig. 12). The tooth is an upper right incisor due to the degree of curvature. The wear surface shows the chisel-shape of rodents where the dentine is worn shorter and at an angle, while the anterior edge is longer and pointed.

Fig. 12 *Castoroides* sp. upper right incisor (SM 66-56-Z) from the Turin locality in lateral view.

Remarks – Grooves on the anterior and lateral surfaces are diagnostic for the genus *Castoroides*. The anteroposterior basal diameter is 26.84 mm. This specimen can be distinguished from incisors of modern *Castor* on the basis of its large size and the structure of the enamel of the incisors. Like this specimen, *Castoroides* incisors have enamel encasing both the anterior surface and lateral surface of the teeth (Barbour 1931). *Castor* incisors only possess enamel on the anterior surface (Barbour 1931). In comparing this specimen with other giant beavers, it is unlikely to be *Procastoroides* since that genus lacks distinct longitudinal enamel grooves (Barbour and Schultz 1937).

There are two Irvingtonian species of *Castoroides*; *Castoroides ohioensis* has a broad geographic range while *Castoroides dilophidus* is limited to the southeastern US (Hulbert et al. 2014).

Genus *CASTOR* Linneaus, 1758

CASTOR sp.

Referred Specimens – SM 24-75-Z (Right Dentary, edentulous), SM 55-75-Z (Left Dentary with p4-m2)

Locality – Turin Pit, IA

Description – One dentary (SM 55-75-Z) contains all teeth except m3 and a partially broken incisor (Fig. 13). Coronoid and articular processes are broken. The angular process projects ventrally and medially from the ventral surface only slightly. The other dentary (SM 24-75-Z) is heavily worn on all processes and missing teeth. It is also broken across the ventral surface through the alveoli of the incisor. The intact dentary (SM 55-75-Z) contains teeth displaying the typical folded pattern of rodents with hypsodont teeth and a large diastema between the molars and the incisor.

Fig. 13 *Castor* left dentary with p4-m2 from Turin (SM 55-75-Z) in occlusal view.

Remarks – Size, proportions, and teeth are similar to modern *Castor canadensis*. The edentulous dentary has deep alveoli where the hypsodont teeth would be. *Castor* is a long-lived genus in North America, first arriving in the late Miocene (Samuels and Zancanella 2011). Its unique morphology makes this specimen relatively straight-forward to identify at the genus level since there are few other genera with which it could be confused. This specimen is smaller than giant beavers and is most similar in dentary and tooth morphology and size to modern *Castor*. There are two species of North American *Castor*, extinct *C. californicus* and extant *C. canadensis*

(Stirton 1935) and there are only small differences between them (Stirton 1935; Lubbers 2022). The length of the striations on the lingual side of the molars can be used to distinguish between *C. canadensis* and *C. californicus* (Stirton 1935), however, the teeth of SM 55-75-Z cannot be removed to observe this trait, so these specimens are only identified to the genus, *Castor* sp.

Family CRICETIDAE Fischer von Waldheim, 1817

Genus *ONDATRA* Linnaeus, 1766

ONDATRA ZIBETHICUS Linnaeus, 1766

ONDATRA ZIBETHICUS ANNECTENS Martin, 1993

Referred Specimens – SM 70-73-Z (Dentary)

Locality – Turin Pit, IA

Description – Left dentary containing the incisor and m1, coronoid and articular processes are missing, masseteric fossa preserved and extends below anterior end of m1 (Fig. 14). Length of the m1 is 5.98 mm. Lower m2 and m3 are absent and alveoli of m2 has two roots. Large diastema present between chisel shaped incisor and m1. The molar has “accordion-shaped” alternating triangles (N=5) with a complex anterolophid.

Fig. 14 *Ondatra zibethicus annectens* left dentary (SM 70-73-Z) from Turin in lateral (top) and occlusal (bottom) view.

Remarks – Dentary has a large diastema and long chisel-shaped incisor that is typical of Cricetidae. Double rooted molar with "accordion-shaped" alternating triangular lophs (N=5) and a complex anterolophid as seen in *Ondatra* (Martin 1996).

What were considered individual muskrat species in the later Cenozoic have more recently been synonymized into a single species, *Ondatra zibethicus*, with different subspecies occurring at different times (Martin 1993). Historically, there were methods used to distinguish between the subspecies when they were considered independent species, however many of those methods are now considered unreliable (Martin 1993). The five alternating lophs indicate that this is a subspecies that predates modern *O. zibethicus zibethicus* since the current subspecies possesses at least seven alternating lophs (Martin 1996). The m1 has well-developed cementum in the re-entrant angles which suggests it is not from one of the two earlier morphs, *O. z. minor* and *O. z. meadensis,* which have less developed or absent cementum (Martin 1996). The length of the m1 falls within the range of length for the subspecies *O. z. annectens* reported from multiple localities (Martin 1996; Martin et al. 2009). This specimen is larger than *O. z. idahoensis* based on the large sample size in Shotwell (1970). This specimen is identified as *Ondatra zibethicus annectens*.

Family GEOMYIDAE Bonaparte, 1845

Genus *GEOMYS* Rafinesque, 1817

GEOMYS sp.

Referred Specimens – SM 89-71-Z (Upper Incisor), TP-029 (Upper Incisor), TP-030 (Upper Incisor), TP-031 (Upper Incisor)

Locality – Turin Pit, IA

Description – Long, curved, unrooted, ever-growing upper incisors with a midline groove down the center of the anterior face, and another groove positioned more medially running parallel down the anterior face.

Remarks – This grooved pattern is a trait found in modern *Geomys* (Pembleton and Williams 1978). Lagomorphs have similarly grooved upper first incisors but only possess the midline groove. Further identification to the species level is not possible with such limited material, thus, this specimen will remain identified as *Geomys* sp.

Order LAGOMORPHA Brandt, 1855

Family LEPORIDAE Fischer von Waldheim, 1817

Subfamily LEPORINAE Indet. Trouessart, 1880

Referred Specimens – SM 18-73-Z (Right astragalus)

Locality – Turin Pit, IA

Description –Small right astragalus which is relatively elongate for its size with a non-constricted neck and a triangular calcaneal articular facet (Fig. 15).

Fig. 15 Left. Leporine right astragalus (SM 18-73-Z) from Turin in posterior (top) and anterior (bottom) views. Right. Modern *Sylvilagus* (ETMNH-Z 7188) in posterior (top) and anterior (bottom) views for comparison.

Remarks – The specimen is similar to modern *Sylvilagus* in general shape and proportions but differed slightly in size with the Turin astragalus being only slightly smaller than the modern comparative specimens. The astragalus has a triangular shaped posterior calcaneal articular facet which is present in modern leporines (Samuels and Schap 2021). Further research and potentially more material would be necessary to identify further than the subfamily level.

Family CAMELIDAE Gray, 1821

Genus *CAMELOPS* Leidy, 1854

CAMELOPS cf. *C. HESTERNUS*

Referred Specimens – TP-028 (Proximal Phalanx), SM 27-74-Z (Metapodial), SM 64-61-Z (Metapodial), SM 65-61-Z (Metacarpal), SM 66-61-Z (Metacarpal), SM 67-61-Z (Proximal Phalanx), SM 71-55-Z (Metapodial), TP-002 (Proximal Phalanx), TP-003 (Proximal Phalanx)

Locality – Turin Pit, IA

Description – Metapodials are large, broad, and elongate. Completely fused 3rd and 4th metapodials, except for divergent distal condyles (Fig. 16). Proximal phalanges are large and elongate (Fig. 16).

Fig. 16 *Camelops* cf. *C. hesternus* from Turin, posterior view of proximal phalanx (TP-028)(top) and anterior view of metacarpal (SM 66-61-Z)(bottom).

Remarks – Proximal phalanges are similar in size and shape to a cast of *Camelops* within the ETMNH-Z collection (ETMNH-Z-5069). Comparison of the proximal phalanx (TP-002) to specimens described by Breyer (1974) allows comparison to three common Pleistocene camelids from the Great Plains, *Titanotylopus*, *Camelops*, and "*Tanupolama*" (=*Hemiauchenia*). The Turin phalanges are not as short and robust as *Titanotylopus* and not as gracile as *Hemiauchenia* (Breyer 1974). Proportionally, they are most similar to *Camelops*. In the Turin specimen, the inflated, rugose area for ligament attachment towards the proximal end of the phalanx on the posterior side extends distally along 1/2 of the shaft as in *Camelops* and unlike the other two genera (Breyer 1974). A recent review of the genus *Camelops* (Baskin and Thomas 2016) determined that there are two common North American species (*C. minidokae* and *C. hesternus*). *C. hesternus* is well known within the Irvingtonian and Rancholabrean, while the smaller *C. minidokae* is primarily known from the Irvingtonian (Baskin and Thomas 2016). The most complete metacarpal from Turin (SM 66-61-Z) measures ~ 395 mm in length which is slightly larger than the largest *Camelops hesternus* measured by Webb (1965). More recently published material identified in Baskin and Thomas (2016) places the Turin specimen at the top of the range (342-394 mm) for *Camelops hesternus*.

Family CERVIDAE Indet. Gray, 1821

Referred Specimens – 3-7-16-63 WDF (Antler)

Locality – Turin Pit, IA

Description – Antler that possesses an anteriorly directed brow tine and a posterior branch, both of which are broken (Fig. 17).

Fig. 17 Cervid antler (3-7-16-63 WDF).

Remarks – Antlers are immediately diagnostic to the family Cervidae (Heckeberg et al. 2022). Based on the morphologies presented in Heckeberg et al. (2022), the morphology of this specimen does not resemble antlers of cervids native to North America today.

Order PERISSODACTYLA Owen, 1848

Family EQUIDAE Gray, 1821

Genus *EQUUS* Linnaeus, 1758

EQUUS sp.

Referred Specimens – SM 71-61-Z (Left P2), SM 57-74-Z (Upper Cheek Tooth), SM 72-61-Z (Upper Cheek Tooth), SM 8-73-Z (Upper Cheek Tooth), SM 44-55-Z (Upper Cheek Tooth), SM 73-56-Z (Upper Cheek Tooth), SM 182-74-Z (Upper Cheek Tooth), SM 85-56-Z (Upper Cheek Tooth), SM 73-73-Z (Upper Cheek Tooth), SM 57-60-Z (Upper Cheek Tooth), SM 66-71-Z (Left

M3), 1-5-22-66 (Right M3), SM 1-75-Z (Upper Cheek Tooth), SM 63-55-Z (Upper Cheek Tooth), SM 26-53-Z (Upper Cheek Tooth), SM 206-58-Z (Upper Cheek Tooth), SM 74-55-Z (Upper Cheek Tooth), TP-025 (Upper Cheek Tooth), SM 14-75-Z (Maxilla Fragment with Tooth), SM 11-74-Z (Upper Cheek Tooth), SM 190-74-Z (Upper Cheek Tooth Fragment), SM 9-57-Z (Upper Cheek Tooth Fragment), SM 15-75-Z (Upper Cheeck Tooth Fragment), SM 171-56-Z (Upper Cheek Tooth Fragment), 2-8-12-76 WDF (Upper Cheek Tooth Fragment), SM 18-57-Z (Upper Cheek Tooth Root), SM 207-58-Z (Lower Cheek Tooth), SM 209-58-Z (Lower Cheek Tooth), SM65-71-Z (Left p2), SM 20-55-Z (Lower Cheek Tooth), SM 2-70-Z (Lower Cheek Tooth), SM 20-75-Z (Lower Cheek Tooth), JB 1-1966 (Left p2), SM 48-55-Z (Lower Cheek Tooth Fragment), SM 20-69-Z (Lower Cheek Tooth Fragment), SM 184-74-Z (Incisor), TP-019 (Incisor), SM 87-75-Z (Incisor Fragment), SM 98-75-Z (Incisor Fragment), SM 10-57-Z (Incisor Fragment), TP-020 (Incisor Fragment),SM 4-70-Z (Astragalus)

Locality – Turin Pit, IA

Description – Many isolated horse cheek teeth and incisors. Cheek teeth show hypsodonty and different levels of wear, have complicated enamel band crenulations in the pattern that is diagnostic of equid teeth. Representative specimens can be seen in Fig. 18. Astragalus has a long continuous trochlea spanning much of the proximal and anterior surfaces with a wide and deep groove down the center (Fig. 18). The astragalus has a short and wide neck with an articular surface, and three articular surfaces on the posterior surface.

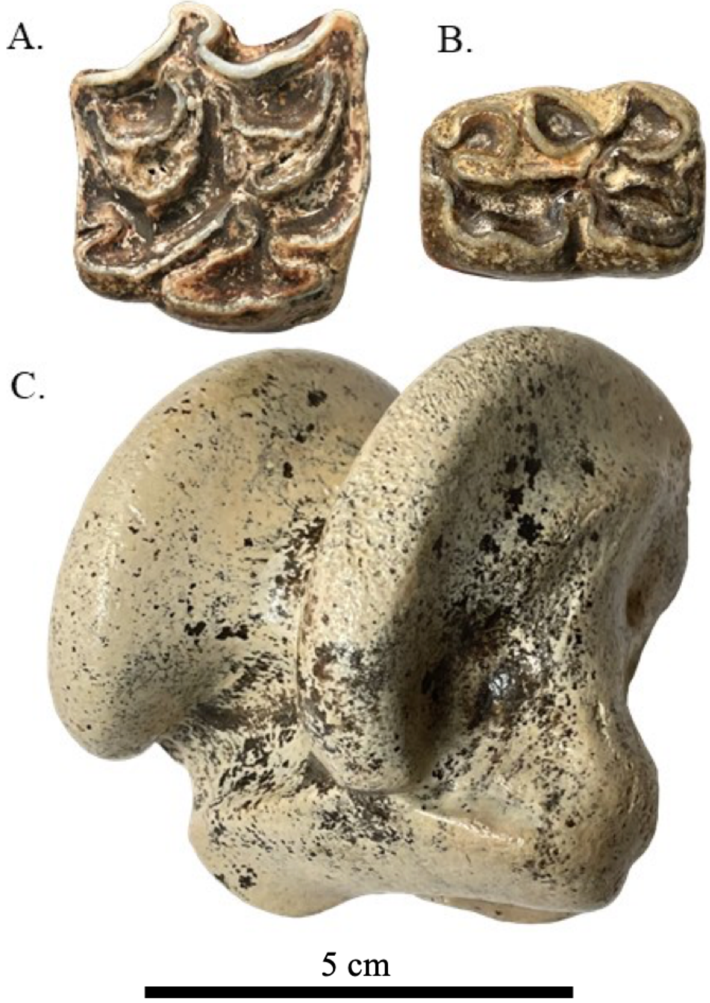

Fig. 18 *Equus* from Turin. A. Upper cheek tooth, occlusal view (SM 73-56-Z). B. Lower cheek tooth, occlusal view (SM 209-58-Z). C. Astragalus (SM 4-70-Z).

Remarks – All material is similar in size and proportion to modern *E. scotti*. Equid material is difficult to identify to the species level due to the extreme splitting of the Pleistocene genus *Equus*. There have been 40 different species of *Equus* identified, but most of these are not well supported and the genus is in need of revision (Barron-Ortiz et al. 2017). The material will remain identified to *Equus* sp. or *Equus* spp. due to the fragmentary nature of the *Equus* fossil record.

Order PROBOSCIDEA Illiger, 1811

Family ELEPHANTIDAE Gray, 1821

Genus *MAMMUTHUS* Brookes, 1828

MAMMUTHUS sp.

Referred Specimens – SM 24-55-Z (Unidentified Molar), TP-039 (Metapodial)

Locality – Turin Pit, IA

Description – Large partial tooth with layered lophs; enamel ridges making up each loph and spanning the width and depth of the tooth (Fig. 19). The Metapodial is very large and robust (length=147.96 mm). The distal end of the metapodial is missing the epiphysis due to incomplete fusion of the growth plate indicating this is a subadult.

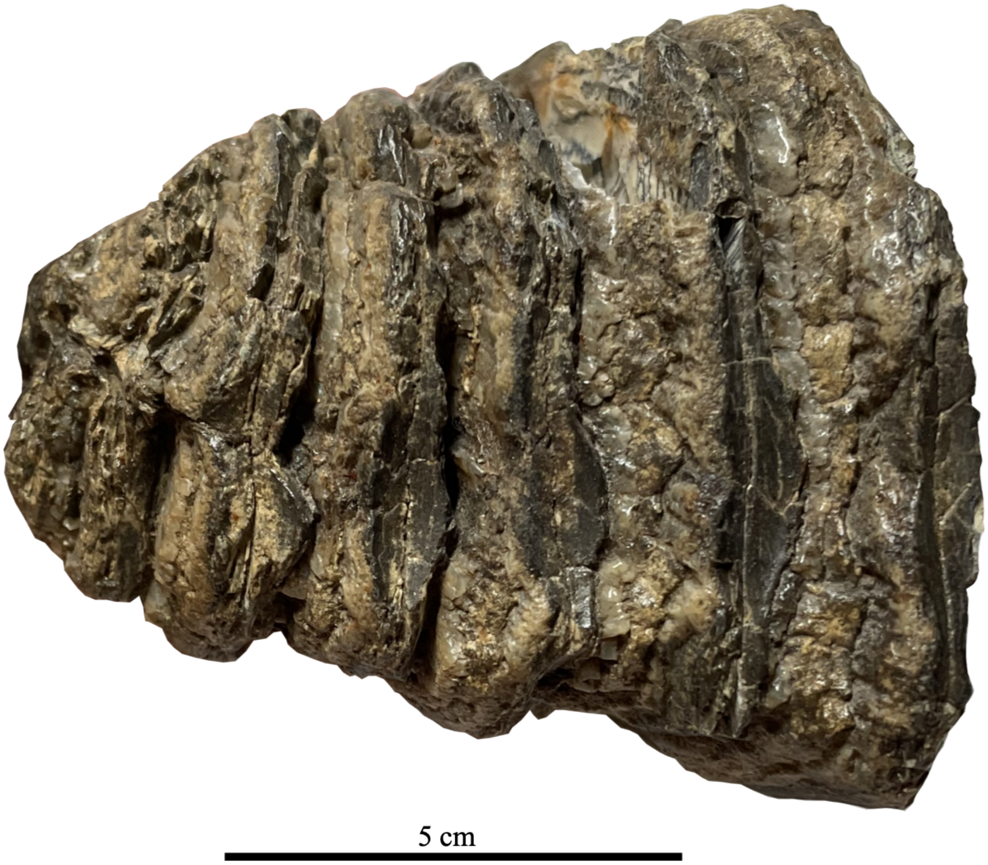

Fig. 19 *Mammuthus* sp. unidentified upper molar (SM 24-55-Z) from the Turin locality in occlusal view.

Remarks – The tooth fragment is a small portion not representative of the entirety of a tooth, but showing the distinctive enamel ridges that are diagnostic of *Mammuthus* teeth (Thomas et al. 2000). SM 24-55-Z has six lophs present. Lophs are relatively tall and straight indicating an upper molar. The metapodial appears more slender than those of *Mammut* which would indicate that this is *Mammuthus* (Olsen 1979). The fragmentary nature of the molar makes morphological characterization difficult. I hesitate to identify this specimen to the species level since Widga et al. (2017; also Enk et al. 2016) indicate that North American *Mammuthus* from the Wisconsin glaciation appear to be of a single genetic population. While there is morphological variation and some regionally-specific morphological groups, all North American mammoths are part of a single genetically similar, morphologically variable population (Enk et al. 2016; Widga et al. 2017). Therefore *Mammuthus* sp. will be the most precise level of identification for the Turin specimens.

Family MAMMUTIDAE Hay, 1922

Genus *MAMMUT* Blumenbach, 1799

MAMMUT AMERICANUM Kerr, 1792

Referred Specimens – SM 63-61-Z (Left M1), SM 176-74-Z (Partial Tooth)

Locality – Turin Pit, IA

Description – SM 63-61-Z (Fig. 20) is complete, consisting of six cusps forming three lophs that span the width of the tooth. There are strong cristae on the anterior and posterior surfaces of posttrite cusps, and the inter-loph valleys are unobstructed (length = 8.4 cm; width = 5.6 cm).

SM 176-74-Z (Fig. 20) is broken anteriorly and heavily worn. Three lophs are also preserved in this specimen, however, the complete length was much longer. Although the tooth is in extreme wear, at least one of the valleys is unobstructed.

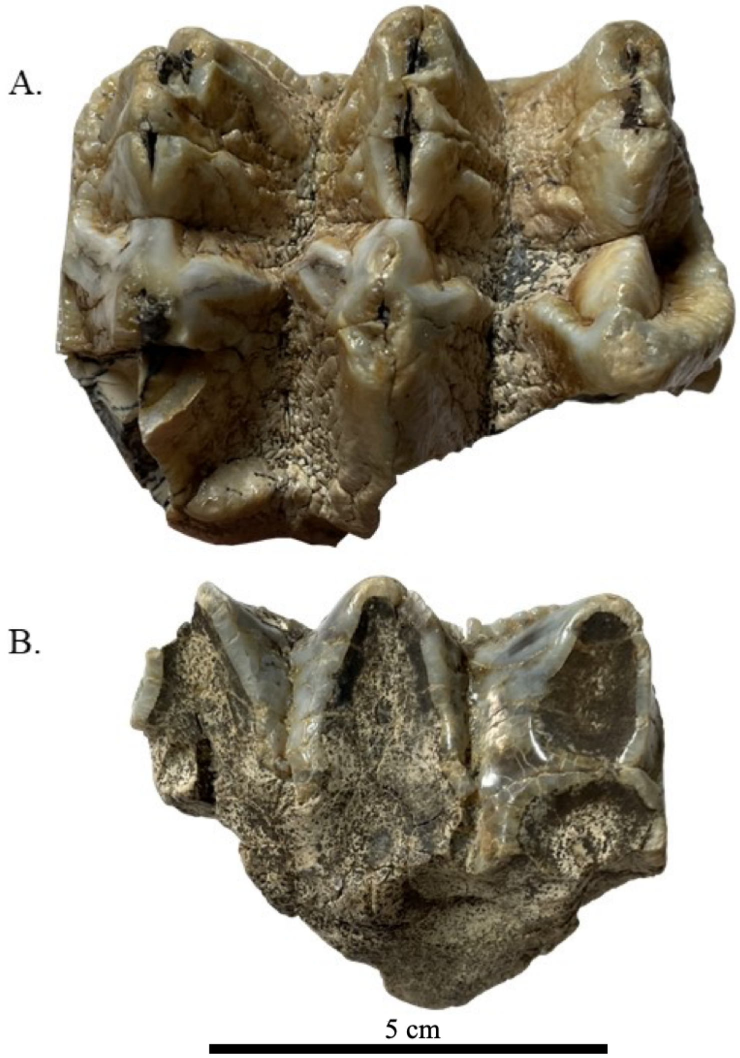

Fig. 20 *Mammut americanum* from Turin. A. Upper left M1 (SM 63-61-Z) in occlusal view. B. Partial tooth in occlusal view (SM 176-74-Z). Scale bar 5 cm.

Remarks – These specimens are identifiable to Mammutidae based on their bunodont molars with unobstructed valleys between the lophs (Tobien 1996). Pleistocene species of *Mammut* are currently undergoing revision to determine if more than one species is present (e.g., Dooley et al. 2019; Karpinski 2021). Historically, Pleistocene members of *Mammut* have been assigned to the species *Mammut americanum.* However, the recent description of *Mammut pacificus* (Dooley et al. 2019) in the western US and molecular datasets indicating the presences of up to five distinct *Mammut* clades (Karpinski 2021) suggest that diversity within the genus has been underestimated in the past. The Turin M1 is wide relative to its length, a state similar to *M. americanum* (Dooley et al. 2019).

Faunal Composition

The Turin faunal assemblage was recovered from sand and gravel deposits. Most of the specimens from the collection exhibit significant weathering and rounding of morphological features, which impede precise taxonomic identification. There are over 500 unidentifiable specimens in the Sanford Museum collection from Turin, many of which are worn and rounded. Of the less worn specimens, not all are included within the systematic paleontology section because they can only be identified to higher levels of classification (e.g., Mammalia). Many specimens (N=69) are relatively complete and unweathered, and can be identified. Of these specimens: (4) preserve morphological features that allow identification to the order, family, subfamily, or tribe level, (62) specimens were identified to genus, and (3) specimens were identified to species (Table 3).

Table 3 Turin faunal list with the number of specimens identified to each taxon.

Taxa	**NISP**
Mammuthus sp.	2
Mammut americanum	2
Megalonyx sp.	1

Equus sp.	41
Camelops cf. *C. hesternus*	9
Aenocyon sp.	1
Caninae Indet.	1
Panthera cf. *P. onca*	1
Mustelidae Indet.	1
Taxidiinae Indet.	1
Castor sp.	2
Castoroides sp.	1
Ondatra zibethicus annectens	1
Geomys sp.	4
Leporinae	1

Age of the Turin Assemblage

The Turin Pit mammal fauna can assist in defining an age for this locality. The presence of *Mammuthus*, *Aenocyon*, and *Castoroides* have chronological significance.

The Leisey Shell pit of Florida is an important locality to be considered for this biochronology. *Aenocyon armbrusteri* and *Castoroides* are reported from Leisey Shell pits (Berta 1995; Morgan and Hulbert 1995). This is one of the first appearances for each of these taxa in North America (Bell et al. 2004). The site is considered to be between 1.55 and 1.1 Ma in age based on biochronology (Morgan and Hulbert 1995; Bell et al. 2004). Leisey Shell pit 1A (1.1-1.3 Ma) is also the oldest confirmed occurrence of *Mammuthus* (Morgan and Hulbert 1995; Lister and Sher 2015). Since both *Castoroides* and *Mammuthus* are found at Turin, their oldest known age of 1.3 Ma (Leisey Shell pit 1A) would define the lower age boundary for Turin.

While the Turin *Aenocyon* specimen cannot be identified to the species level, the first occurrence of *Aenocyon armbrusteri* would still be the first occurrence of the genus *Aenocyon*, so the Turin *Aenocyon* specimen does add support for the lower age boundary being ~1.3 Ma despite only a genus-level identification.

Defining the upper age boundary for Turin is more difficult because many of the taxa from this site are still extant (e.g. Members of Caninae, *Panthera*, members of Mustelidae and Taxidiinae, *Castor*, *Ondatra zibethicus*, *Geomys*, and *Sylvilagus*). However, the geographic ranges for some of these taxa do not currently reach Iowa. The majority of extinct taxa found at Turin vanished at the end of the Pleistocene. This is true of *Mammuthus*, *Mammut*, *Megalonyx*, *Equus*, *Camelops*, and *Castoroides* (Faith and Surovell 2009).

There are currently two possible *Aenocyon* species present in the Turin Pit fauna, *A. armbrusteri* and *A. dirus.* One of the youngest records of *A. armbrusteri* discussed by Bell et al. (2004) is from Coleman 2A of Florida which is thought to be 0.5-0.3 Ma in age (Morgan and Hulbert 1995). However, *Aenocyon dirus* is limited to the Rancholabrean with its first appearance being 0.252 Ma (Dundas 1999). If the specimen were further identified as *A. dirus* the identification could mean a number of things for the biochronology. Either Turin is much younger than other evidence suggests, there is extreme time averaging occurring with the site having a large age range, or this is a very early occurrence of *A. dirus*. Without further means to identify the species, the Turin Pit *Aenocyon* does not currently have implications for the upper age boundary due to the conflicting nature of the two possible species in regards to the biochronology.

Ondatra zibethicus annectens has been classified as an index taxon for Rodent Zones 7 and 9 as defined by Martin (2021). This subspecies has an age range of 2.0-0.63 Ma (Martin

2021). The presence of this taxon at Turin gives support for this being an Irvingtonian site as this taxon has a biostratigraphically constrained upper age boundary of 0.63 Ma.

Stratigraphic information can also be used to refine the age of Turin. Roy et al. (2004) assigned the magnetically-reversed till overlying the fossil-bearing sand and gravel deposit to the R1 group deposited between 1.3 and 0.8 Ma. At the time of Roy's 2004 publication, 0.8 Ma was considered to be the end of the last reversal, but more recent work has refined the age of the last polar reversal to 0.773 Ma (Head and Gibbard 2015). The Turin Pit locality is listed as only having a glacial till overlain by loess as the exposed stratigraphy (Roy et al. 2004). Only loess and the R1 till were exposed during when Roy visited Turin (Martin Roy pers. comm.). However, according to older stratigraphic accounts and well logs in the Turin area, the sand and gravel deposit which this fauna was excavated from sits above a glacial till and is overlain by a glacial till and loess (Shimek 1910). This indicates that the area sampled by Roy et al. (2004) is the till overlying the sand and gravel deposit, and the youngest possible age for the till is likely the youngest possible age for the sand and gravel deposit, ~0.773 Ma.

The age of the Turin Pit fauna is constrained by the presence of *Aenocyon*, *Mammuthus* and *Castoroides*, and the end of the last polar reversal providing an overall age estimate of ~1.3-0.773 Ma for the assemblage (Fig. 21). This age range includes MIS 20-45 (Head and Gibbard 2015). The age of this assemblage also corresponds to the Early-Middle Pleistocene transition when an increase in the severity of climate shifts began following 100 ka orbital cycles (Head and Gibbard 2015).

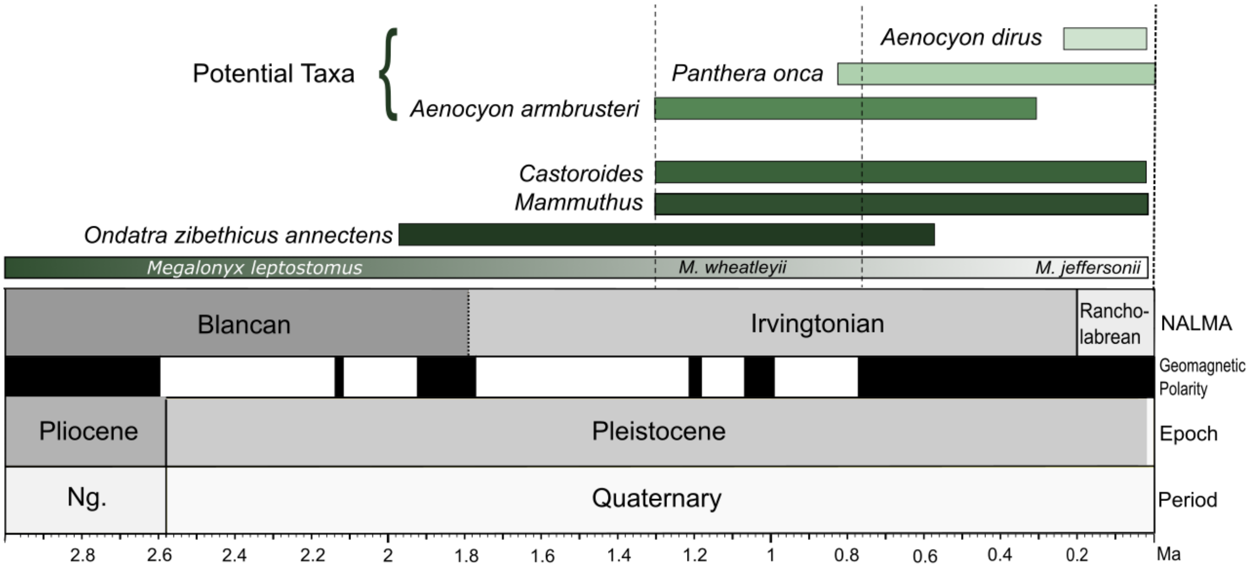

Fig. 21 Biochronology of relevant taxa at the Turn Pit site. Dotted lines represent the boundaries of the age, defined by the appearance of *Aenocyon*, *Castoroides*, and *Mammuthus* at ~1.3 Ma (Morgan and Hulbert 1995), along with the end of the last reversal (Roy et al. 2004). *Aenocyon armbrusteri, Aenocyon dirus,* and *Panthera onca* are included as potential taxa, and their implications to the biochronology are discussed elsewhere. The timescale including the NALMAs, Geomagnetic Polarity, Epochs, and Periods is modified from https://timescalecreator.org/.

CHAPTER 5. DISCUSSION

This thesis project has identified specimens from the Turin Pit to mammalian taxonomic groups. However, not every identification is consistent with our current understanding of the known temporal and geographic ranges of these taxa.

The genus *Aenocyon*

Perri et al. (2021) conducted a molecular-based phylogenetic study and found that the dire wolf, *Canis dirus*, was more basal in the Canina subtribe than all the other members that were sampled (*Lupullela mesomelas*, *Lupullela adustus*, *Lycaon pictus*, *Cuon alpinus*, *Canis simensis*, *Canis lupaster*, *Canis latrans*, and *Canis lupus*). Due to this more basal position in the phylogeny and the desire for monophyletic *Canis*, it was suggested that the genus name for the dire wolf revert back to *Aenocyon* (Perri et al. 2021). Their work also showed that *A. dirus* diverged from *Canis* and other extant canid genera ~5.7 Ma and may not have introgressed with other contemporary *Canis* species (Perri et al. 2021). *A. armbrusteri* and *A. dirus* have been accepted in recent years as being close sister taxa within the subtribe Canina (Tedford et al. 2009) with some researchers suggesting that the two represent chronospecies (Nowak 2002). The two forms are very similar in morphology to the point that the main difference between them is size and some minor dental characters (Tedford et al. 2009). The two species are considered to share an evolutionary lineage due to their morphological similarity and chronology. There are likely earlier North American canids that are also part of this lineage, but that is outside the scope of this thesis project and those species should be evaluated in future research.

The Appearance of *Panthera* in North America

The large cat maxilla from Turin Pit that is identified as *Panthera* cf. *P. onca* has interesting implications for the arrival of the genus in North America. *P. onca* arrives during the

Irvingtonian NALMA (Seymour 1993; Kurten and Anderson 1980) while *P. atrox* is currently considered to be limited to the Rancholabrean NALMA (Bell et al. 2004). *P. spelaea* is also thought to appear during the Rancholabrean NALMA (Kurten and Anderson 1980). Seymour (1993) indicates that the earliest recorded occurrence of *P. onca* is from 0.85-0.82 Ma. The Turin Pit fauna is older than 0.773 Ma (Roy et al. 2004). If this specimen is *P. onca*, this would be one of the earliest occurrences of the species in North America. The other possible implication of identifying *P. onca* at Turin is that it would greatly restrict the potential age range for the site to 0.85-0.773 Ma.

Evolution of *Megalonyx*

The skull of a giant ground sloth from Turin has been previously identified as *Megalonyx jeffersonii* (McDonald and Anderson 1983)(Fig. 22). McDonald and Anderson (1983) describe the skull in detail and list the characters they use to identify it to the genus *Megalonyx* (e.g. temporal fossa and closed zygomatic arches). The specimen was identified as *Megalonyx jeffersonii* on the basis of three morphological characters (slope of occiput to basicranium, fossae of rectis capitis ventralis muscles, and stylohyal pit) and measurements (McDonald and Anderson 1983). However, specimens used for comparative measurements included only one skull of *M. wheatleyi*, and multiple skulls of *M. jeffersonii* suggesting poor resolution of the morphological differences between different species of *Megalonyx*. Furthermore, the primary morphological character in the cranium that is used to distinguish between *M. wheatleyi* and *M. jeffersonii* is a lingual bulge on the caniniform (McDonald 1977), which is an element missing from the Turin Pit specimen.

Only five species are currently supported in revisions of *Megalonyx* (*M. mathisi*, *M. curvidens*, *M. leptostomus*, *M. wheatleyi*, and *M. jeffersonii*) (McDonald 1977). Among these taxa, there are few distinguishable characters so it has been suggested that the constellation of *Megalonyx* spp. is a chronospecies (Fields 2009). Fields (2009) suggested the synonymy of at least the two latest forms, *M. wheatleyi* and *M. jeffersonii*. They found no significant qualitative or quantitative differences between the two taxa. Previously, McDonald and Anderson (1983) also suggested that the genus was in need of revision due to a large degree of variation in characters that have been used to define species of *Megalonyx*. Despite this, the different forms of *Megalonyx* have not been formally synonymized. Although a thorough description of this specimen resulted in a species-level identification (McDonald and Anderson 1983) we consider the status of this identification more tentative in the absence of reliable morphological characters to distinguish *M. wheatleyi* and *M. jeffersonii*. Further review of *Megalonyx* skull morphology across a broader sample of specimens could result in a more precise identification.

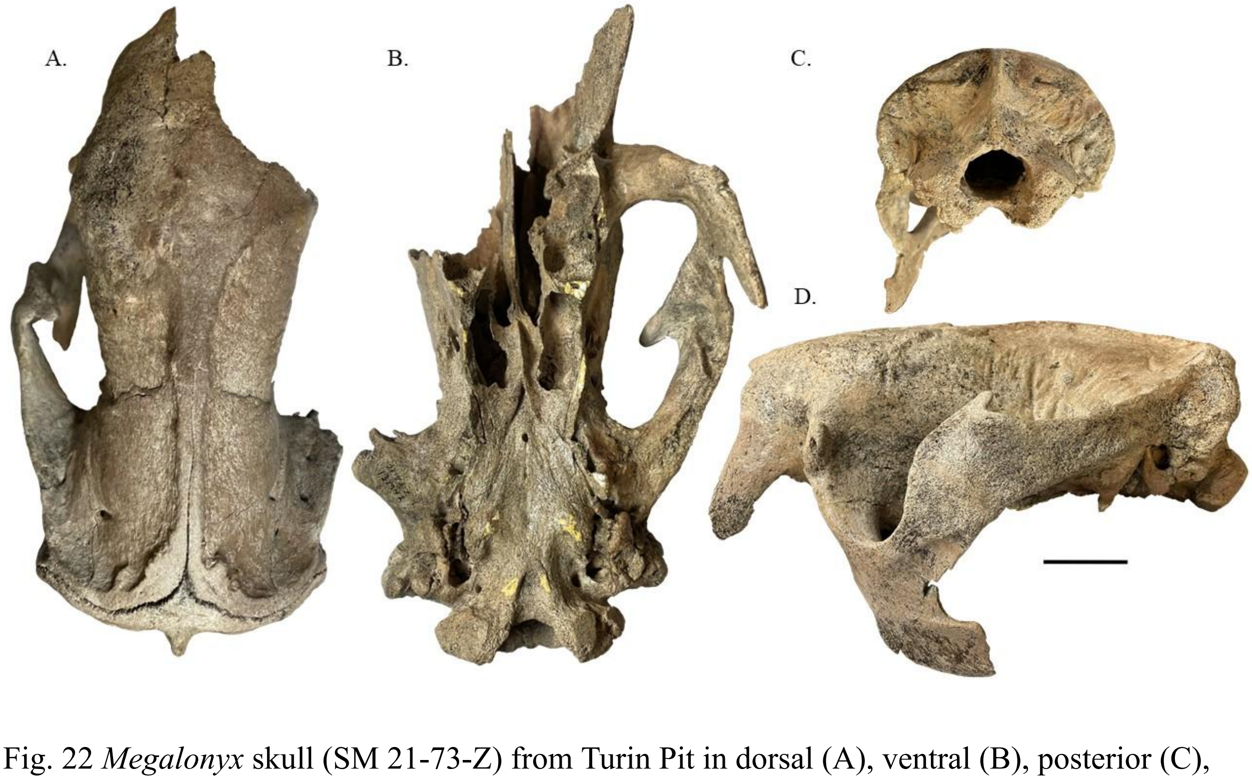

Fig. 22 *Megalonyx* skull (SM 21-73-Z) from Turin Pit in dorsal (A), ventral (B), posterior (C), and left lateral (D) views. Skull edentulous, complete with the exception of missing the anterior

and palate portion of the right maxilla and missing the anterior end of the right nasal and right zygomatic arch, likely a mature adult due to little visible manifestation of cranial sutures. Scale bar 5 cm.

The species-level identity of the Turin Pit *Megalonyx* is important because *M. jeffersonii* has been historically restricted to the Rancholabrean NALMA (Bell et al. 2004). Further research into the genus *Megalonyx* since this original identification has shown that the species are difficult to distinguish, with some researchers suggesting synonymy of at least the latest two species *M. wheatleyi* and *M. jeffersonii* (Fields 2009). Another Late Irvingtonian *Megalonyx* from the Camelot fauna of South Carolina (~0.45 Ma) was identified as a transitional form between *M. wheatleyi* and *M. jeffersonii* and was the basis for the suggested synonymy (Fields 2009). Revision of the genus may be necessary to better define morphological changes and to determine the validity of each species.

The Turin Pit Biochronology

One of the most debated aspects of the Turin faunal assemblage has been its age. Early 20th century paleontologists thought the site dated to the "Early" Pleistocene (Calvin and Lees 1910; Hay 1914). More recently, researchers have suggested that the Turin fauna dates to the Late Pleistocene (Rhodes and Semken 1986), a sharp contrast to earlier research. This project has refined an age range for the Turin Pit locality based on stratigraphic and biostratigraphic evidence. Turin Pit can be associated with the Irvingtonian NALMA based on four taxa, *Mammuthus*, *Castoroides*, and *Aenocyon* which indicate that the Turin fauna must be of the Irvingtonian or younger, and *Ondatra zibethicus annectens* which limits the fauna to only the Irvingtonian

Not every taxon identified in this study is helpful for refining the age. Many appeared in the Blancan and survived until the Rancholabrean. Other taxa could be biostratigraphically useful if further identification to the species level were possible. For instance, there are three species of *Panthera* in North America during the Pleistocene, *P. onca*, *P. atrox*, and *P. spelaea* (Kurten and Anderson 1980; Barnett et al. 2016). *P. onca* appears earliest, in the middle of the Irvingtonian, making it the most likely candidate for the Turin *Panthera*. *P. atrox* is currently only known from the Rancholabrean of North America (Wheeler and Jefferson 2009) and *P. spelaea* occupied much of Eurasia and the Beringian portion of North America, not entering the lower 48 states of the U.S. (Barnett et al. 2016). Seymour (1993) lists some of the earliest known records of *P. onca* in North America and indicates a maximum age of *Panthera* in the middle Irvingtonian NALMA, approximately 0.82-0.85 Ma (Seymour 1993). This is a possibility for a lower boundary age for the Turin locality. However, given the rarity of large carnivores in the fossil record, it may be that Turin is simply an earlier occurrence of jaguar, so it is unwise to base the maximum age of the site on this taxon alone. Because it is an extant species, *Panthera onca* cannot be used to provide a minimum age for the assemblage.

Due to the difficulty in distinguishing middle and late Pleistocene species of *Megalonyx*, the Turin specimen is considered *Megalonyx* sp. It is clearly a member of the genus *Megalonyx* (McDonald and Anderson 1983) and likely one of the two later forms based on size and some of its morphological characteristics. However, this specimen may be a transitional form between *M. wheatleyi* and *M. jeffersonii* as was suggested for the Camelot, SC, *Megalonyx* (Fields 2009). This conservative identification of *Megalonyx* sp. and the question of synonymy within the genus means that the biochronological significance of the Turin Pit *Megalonyx* is unclear.

Finally, the Turin Pit fauna contains a number of taxa that clearly place it within the Irvingtonian NALMA. Despite this clear affinity to Irvintonian faunas, it is difficult to relate the Turin locality to the temporal divisions within the Irvingtonian (e.g., Irvingtonian I, Irvingtonian II, Irvingtonian III) which are based on the first appearances of a number of different arvicoline (vole) species (*Phenacomys*, *Microtus*, *Lemmiscus*, etc.) (Bell et al. 2004). Turin contains mostly large mammals due to taphonomic processes and collecting methods used at the site. Very few excavations occurred and no sediment was collected for screening, so there are few small species known from the site. Therefore, the lack of controlled excavations or screening at Turin makes it so we cannot be sure what rodent species are present and, therefore, cannot apply more precise biostratigraphic divisions to the Turin assemblage.

The Turin Pit Environment

The lack of small rodent fossils from Turin also inhibits the ability to infer paleoenvironmental details and allow comparisons of the Turin fauna to other known Irvingtonian localities. Large mammals like those found at Turin have large geographic ranges and inhabit a variety of habitats, but smaller mammals like rodents tend to have individual species best suited for certain environments (Bowman et al. 2002; Fortelius et al. 2014). Many of the Irvingtonian faunas discussed in Bell et al. (2004) include vole species which are indicators of the age. These taxa are unknown from Turin.

However, some taxonomic groups found at Turin have ecological preferences that we can use to make inferences about the local environment. Isotopic analyses of collagen samples from *Megalonyx jeffersonii* have shown a preference for C3 plants indicating that it was likely a browser that preferred forested habitats (Kohn et al. 2005; McDonald et al. 2019). While the Turin Pit sloth is no longer unambiguously identified as *M. jeffersonii*, it can be inferred that other members of the genus were also browsers because of their close phylogenetic relationships and morphological similarity.

Koch et al. (1998) analyzed the isotopes present in enamel apatite across some late Pleistocene species. It was found that *Mammut* primarily consumed C3 trees and shrubs while *Mammuthus* primarily consumed C4 grasses. The presence of both *Mammuthus* and *Mammut* at Turin suggests that either both grassland and woodland habitats were nearby, and that this could have been a marginal area on the border between the two, or that we are seeing time averaging as the environment changed from one habitat to another. Another possibility is that the species are not entirely restricted in their diets and consume similar vegetation especially since both genera migrate long distances (Widga et al. 2020). Another taxon that may not have had a restricted diet is *Camelops* (Yann et al. 2016). Stable carbon isotope analyses of *Camelops* show that they exhibit a large range in their $\delta^{13}C$ values, indicating that they may be mixed feeders that consume both C4 and C3 vegetation (Yann et al. 2016). Yann et al. (2016) suggests that they may be opportunistic browsers, and this feeding strategy allows them to succeed in a wider range of habitats.

Equus has long been interpreted to be primarily a grazer, having high $\delta^{13}C$ values from localities where C4 grasses were common indicating they almost exclusively grazed in those areas (MacFadden and Cerling 1996). However, they also consumed mixed C4 and C3 grasses depending on location and available vegetation (MacFadden and Cerling 1996; Kohn et al. 2005).

Taxidiinae as a subfamily is believed to have evolved to prey on burrowing rodents in open environments across North America (Owen 2000). This is something that can be observed in the modern representative of this subfamily. In a recent study by Doyle et al. (2019) they found that in areas where previous habitat has been altered for human use, *Taxidea* preferred unmodified open grasslands and agricultural land.

Beavers are specialized for aquatic environments and are reliant on bodies of water such as rivers and lakes for shelter and transportation to food sources (Shelton 1966; Müller-Schwarze 2011). They also alter their environments by building dams, and digging canals and burrows (Shelton 1966; Müller-Schwarze 2011). The muskrat is another rodent that is known to prefer aquatic environments and specifically still-water environments with vegetation like marshes and ponds (Proulx and Gilbert 1983). The presence of two different species that are so closely tied to aquatic environments, *Castor* and *Ondatra*, give strong support for the close proximity of aquatic environments. Turin is also known to have fossils of several species of freshwater mollusks (Shimek 1910).

The Turin fauna exhibit habitat preferences for both open grassland and woodland environments. This may indicate a number of possibilities. The local environment at Turin may have been a mosaic of habitats, as is often found at the edge of major river valleys. We could also be seeing time averaging as the locality changed from one habitat to the other. The vast majority of the fossils from this deposit are rounded and weathered, and there are a handful of aquatic mammalian taxa now identified from Turin as well (*Ondatra* and *Castor*). With the Turin sand and gravel layer being a fluvial deposit, another possibility to explain two environmental preferences is that the deposit is taphonomically mixed.

CHAPTER 6. CONCLUSIONS

The Turin Pit locality is estimated to have an age range of 1.3-0.773 Ma and contains a fauna characteristic of the Irvingtonian NALMA. This reassessment of fossils from Turin informs a new understanding of the taxa, biochronology, and paleoenvironment of the site. While older glacial and interglacial terms are no longer used, a new understanding of the age of this site can help place the "Aftonian" sand and gravel localities of western Iowa into a proper chronological context. The presence of *Mammuthus*, *Castoroides*, *Aenocyon*, and *Ondatra zibethicus annectens* allows for the Turin fauna to be assigned to the Irvingtonian NALMA. The Turin fauna could add to our understanding of the Irvingtonian NALMA since fossil localities of this age are rare within the region. The paleoenvironment at Turin cannot be well understood at this time except that it likely included an aquatic environment and the history of the environment may be complicated by the taphonomic factors.

Identification of the mammalian fossils from Turin allows us to update the faunal list (Table 3). Fifteen distinct taxa are represented in the Turin local fauna. However, due to limitations of this project, not all of the Turin fossil material was evaluated, and further research is necessary to fully characterize the fauna and estimate the taxonomic diversity present at Turin. Discussion of these updated taxonomic identifications provides further insight into the individual taxa. Turin could be one of the earliest occurrences of the genus *Panthera* in North America or possibly the species *Panthera onca*. Through the process of identifying the *Aenocyon* specimen at Turin and evaluating recent research has led to rethinking the generic level placement of *Aenocyon armbrusteri*. Since the identification of the Turin sloth skull, the validity of species within *Megalonyx* have been questioned, and a species level identification of this skull is not well supported. Further research into these taxa is necessary to fully understand the environment at Turin. With much of Iowa's Quaternary paleontological sites being from the last glacial period or the Holocene, we now have a window into the paleontology of an earlier time for the state.

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