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Manus Descriptions of an Undescribed Mastodon from the Latest Miocene-Earliest Pliocene
Gray Fossil Site, with Comparisons to other North American Proboscidean Taxa

A thesis
presented to
the faculty of the Department of Geosciences
East Tennessee State University

In partial fulfillment
of the requirements for the degree
Master of Science in Geosciences

by
Brenna J. Hart-Farrar
December 2019

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Keywords: Gray Fossil Site, *Mammut*, Mastodon, Morphology, Manus

ABSTRACT

Manus descriptions of an Undescribed Mastodon from the Latest Miocene-Earliest Pliocene
Gray Fossil Site, with Comparisons to other North American Proboscidean Taxa

by

Brenna J. Hart-Farrar

A detailed morphological description of a proboscidean manus from the Gray Fossil Site (GFS), Gray, Tennessee is provided. Manus elements from an American mastodon (*Mammut americanum*), a Britt's shovel-tusker (*Amebelodon britti*), an undescribed small gomphothere species, and a Columbian mammoth (*Mammuthus columbi*) are used for comparisons. Linear measurements indicate proportional differences between the GFS mastodon and other proboscidean taxa ranging from the Hemphillian to Rancholabrean land mammal ages. Possible pathologies are also described. The purpose of this study is to determine how the GFS mastodon differs in manus morphology and locomotion from different proboscidean taxa, including size, environmental, evolutionary, and taxonomic factors. Morphological differences are more pronounced in carpals and metacarpals in regard to shape, size, and orientation of articular surfaces but are not statistically compared due to the small sample size.

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TABLE OF CONTENTS

ABSTRACT.....	2
TABLE OF CONTENTS.....	5
LIST OF FIGURES	11
CHAPTER 1. INTRODUCTION	16
Background Review of Proboscidea and Mammut.....	18
Gray Fossil Site.....	24
CHAPTER 2. METHODS	27
Collection and Conservation.....	27
Measurements and Photography	28
Museums and Species	28
Post-Cranial Comparisons.....	29
Abbreviations	30
Museums, Localities, and Others.....	30
Articular Surfaces	30
CHAPTER 3. GRAY MASTODON OF THE GRAY FOSSIL SITE	34
Left Manus	35
Carpals	35
Pisiform.....	35
Cuneiform.	37
Lunar.....	41
Scaphoid.....	46
Unciform.....	50
Magnum.....	55
Trapezoid.	61
Trapezium.	65
Metacarpals.....	69
Metacarpal I.	69
Metacarpal II.....	74
Metacarpal III.	80
Metacarpal V.....	85
Phalanges	88

Proximal Phalanges.....	91
Proximal Phalanx Digit I.	91
Proximal Phalanx Digit II.....	95
Proximal Phalanx Digit III.....	99
Proximal Phalanx Digit IV	104
Proximal Phalanx Digit V.....	108
Medial Phalanges	112
Medial Phalanx Digit II.	112
Medial Phalanx Digit III.....	115
Medial Phalanx Digit IV.....	119
Medial Phalanx Digit V.	123
Terminal Phalanges.....	127
Terminal Phalanx Digit III.....	127
Sesamoids.	131
Metacarpal I Sesamoids.	131
Metacarpal II Sesamoids.....	133
Metacarpal III Sesamoids.	137
Metacarpal IV Sesamoid.....	141
Metacarpal V Sesamoids.	143
CHAPTER 4. <i>Mammot americanum</i> FROM AUCILLA RIVER	147
Right Manus	147
Carpals	147
Trapezoid.	147
Metacarpals.....	152
Metacarpal IV.	152
Left Manus	157
Carpals	157
Cuneiform.	157
Lunar.....	161
Scaphoid.....	165
Unciform.....	169
Magnum.....	173

Trapezium.....	178
Metacarpals.....	181
Metacarpal I.....	181
Metacarpal II.....	185
Metacarpal III.....	189
Metacarpal IV.....	193
Metacarpal V.....	198
Phalanges.....	202
Proximal Phalanges.....	202
Proximal Phalanx Digit II.....	202
Proximal Phalanx Digit III.....	206
Proximal Phalanx Digit IV.....	209
Proximal Phalanx Digit V.....	213
Medial Phalanges.....	216
Medial Phalanx Digit II.....	216
Medial Phalanx Digit III.....	219
Medial Phalanx Digit IV.....	222
Medial Phalanx Digit V.....	225
Sesamoids.....	228
CHAPTER 5. <i>Amebelodon britti</i> FROM MOSS ACRES RACETRACK.....	229
Left Manus.....	229
Carpals.....	229
Pisiform.....	229
Cuneiform.....	232
Lunar.....	235
Scaphoid.....	238
Unciform.....	242
Magnum.....	246
Trapezoid.....	250
Trapezium.....	254
Metacarpals.....	257
Metacarpal I.....	257

Metacarpal II.....	260
Metacarpal III.....	264
Metacarpal IV.....	268
CHAPTER 6. SMALL GOMPHOTHERE FROM MONTBROOK.....	271
Right Manus.....	271
Carpals.....	271
Pisiform.....	271
Cuneiform.....	274
Unciform.....	277
Magnum.....	281
Metacarpals.....	285
Metacarpal II.....	285
Metacarpal III.....	289
Phalanges.....	293
Proximal Phalanges.....	293
Proximal Phalanx Digit III.....	293
CHAPTER 7. <i>Mammuthus columbi</i> FROM HARRISON RANCH SITE.....	296
Left Manus.....	296
Carpals.....	296
Pisiform.....	296
Cuneiform.....	299
Lunar.....	302
Scaphoid.....	306
Unciform.....	312
Magnum.....	316
Trapezoid.....	320
Trapezium.....	324
Metacarpals.....	327
Metacarpal I.....	327
Metacarpal II.....	330
Metacarpal III.....	334
Metacarpal IV.....	338

Metacarpal V.....	343
Phalanges	347
Proximal Phalanges.....	347
Proximal Phalanx Digit II.....	347
Proximal Phalanx Digit III.....	351
Proximal Phalanx Digit IV	354
Proximal Phalanx Digit V.....	357
Medial Phalanges	360
Medial Phalanx Digit II.....	360
Medial Phalanx Digit III.....	363
Medial Phalanx Digit IV.....	366
Terminal Phalanges.....	369
Terminal Phalanges Digit I, II, IV, & V.....	369
Terminal Phalanx Digit III.....	369
Sesamoids	371
CHAPTER 8. RESULTS	373
Carpal Comparisons	373
Pisiform.....	373
Cuneiform.....	373
Lunar	375
Scaphoid.....	376
Unciform.....	377
Magnum	379
Trapezoid	381
Trapezium	382
Metacarpal Comparisons.....	383
Metacarpal I	383
Metacarpal II.....	383
Metacarpal III	384
Metacarpal IV	384
Metacarpal V.....	384
Phalange Comparisons	385

Sesamoid Comparisons	385
CHAPTER 9. DISCUSSION & CONCLUSIONS.....	387
Morphological Description	387
Implications for Mammut	392
Future Work	392
REFERENCES	394
VITA.....	403

LIST OF FIGURES

Figure 1: Proboscidean Phylogenetics (modified from Shoshani et al. 2007	21
Figure 2: Gray Fossil Site within Tennessee. Modified after Shunk et al. 2006.	24
Figure 3: Left Manus of ETMNH 305	34
Figure 4: Left pisiform of ETMNH 305.	36
Figure 5: Left cuneiform of ETMNH 305.	40
Figure 6: Left lunar of ETMNH 305.....	45
Figure 7: Left scaphoid of ETMNH 305.....	49
Figure 8: Left unciform of ETMNH 305.	54
Figure 9: Left magnum of ETMNH 305.....	60
Figure 10: Left trapezoid of ETMNH 305.....	64
Figure 11: Left trapezium of ETMNH 305.....	68
Figure 12: Left Metacarpal I of ETMNH 305	73
Figure 13: Left Metacarpal II of ETMNH 305.	79
Figure 14: Left Metacarpal III of ETMNH 305.....	84
Figure 15: Left Metacarpal V of ETMNH 305.....	90
Figure 16: Left proximal phalanx of digit I of ETMNH 305.....	94
Figure 17: Left proximal phalanx of digit II of ETMNH 305.	98
Figure 18: Left proximal phalanx of digit III of ETMNH 305.....	103
Figure 19: Left proximal phalanx of digit IV of ETMNH 305.....	107
Figure 20: Left proximal phalanx of digit V of ETMNH 305.....	111
Figure 21: Left medial phalanx of digit II of ETMNH 305.....	114
Figure 22: Left medial phalanx of digit III of ETMNH 305.....	118
Figure 23: Left medial phalanx of digit IV of ETMNH 305.	122

Figure 24: Left medial phalanx of digit V of ETMNH 305.....	126
Figure 25: Left terminal phalanx of digit III of ETMNH 305.....	130
Figure 26: Left Metacarpal I fused sesamoids of ETMNH 305.	132
Figure 27: Left Metacarpal II lateral sesamoid of ETMNH 305.	135
Figure 28: Left Metacarpal II medial sesamoid of ETMNH 305.	136
Figure 29: Left Metacarpal III lateral sesamoid of ETMNH 305.....	139
Figure 30: Left Metacarpal III medial sesamoid of ETMNH 305.....	140
Figure 31: Left Metacarpal IV lateral sesamoid of ETMNH 305.....	142
Figure 32: Left Metacarpal V lateral sesamoid of ETMNH 305.....	145
Figure 33: Left Metacarpal V medial sesamoid of ETMNH 305.....	146
Figure 34: Right trapezoid of UF 137891.....	151
Figure 35: Right Metacarpal IV of UF 137891	156
Figure 36: Left cuneiform of UF 137891.	160
Figure 37: Left lunar of UF 137891.....	164
Figure 38: Left scaphoid of UF 137891.....	168
Figure 39: Left unciform of UF 137891.	172
Figure 40: Left magnum of UF 137891.....	177
Figure 41: Left trapezium of UF 137891.....	180
Figure 42: Left Metacarpal I of UF 137891.....	184
Figure 43: Left Metacarpal II of UF 137891.	188
Figure 44: Left Metacarpal III of UF 137891.....	192
Figure 45: Left Metacarpal IV of UF 137891.....	197
Figure 46: Left Metacarpal V of UF 137891.....	201
Figure 47: Left proximal phalanx of digit II of UF 137891.	205

Figure 48: Left proximal phalanx of digit III of UF 137891.....	208
Figure 49: Left proximal phalanx of digit IV of UF 137891.....	212
Figure 50: Left proximal phalanx of digit V of UF 137891.....	215
Figure 51: Left medial phalanx of digit II of UF 137891.....	218
Figure 52: Left medial phalanx of digit III of UF 137891.....	221
Figure 53: Left medial phalanx of digit IV of UF 137891.....	224
Figure 54: Left medial phalanx of digit V of UF 137891.....	227
Figure 55: Left pisiform of UF 69997.....	231
Figure 56: Left cuneiform of UF 69997.....	234
Figure 57: Left lunar of UF 69997.....	237
Figure 58: Left scaphoid of UF 69997.....	241
Figure 59: Left unciform of UF 69997.....	245
Figure 60: Left magnum of UF 69997.....	249
Figure 61: Left trapezoid of UF 69997.....	253
Figure 62: Left trapezium of UF 69997.....	256
Figure 63: Left Metacarpal I of UF 69997.....	259
Figure 64: Left Metacarpal II of UF 69997.....	263
Figure 65: Left Metacarpal III of UF 69997.....	267
Figure 66: Left Metacarpal IV of UF 69997.....	270
Figure 67: Right pisiform of UF 423090.....	273
Figure 68: Right cuneiform of UF 423090.....	276
Figure 69: Right unciform of UF 423090.....	280
Figure 70: Right magnum of UF 423090.....	284
Figure 71: Right metacarpal of UF 423090.....	288

Figure 72: Right metacarpal III of UF 423090.	292
Figure 73: Right proximal phalanx of digit III of UF 423090.	295
Figure 74: Left pisiform of UF 256400.	298
Figure 75: Left cuneiform of UF 256400.	301
Figure 76: Left lunar of UF 256400.	305
Figure 77: Left proximal scaphoid of UF 256400.	309
Figure 78: Left distal scaphoid of UF 256400.	310
Figure 79: Left proximal and distal combined scaphoids of UF 256400.	311
Figure 80: Left unciform of UF 256400.	315
Figure 81: Left magnum of UF 256400.	319
Figure 82: Left trapezoid of UF 256400.	323
Figure 83: Left trapezium of UF 256400.	326
Figure 84: Left Metacarpal I of UF 256400.	329
Figure 85: Left Metacarpal II of UF 256400.	333
Figure 86: Left Metacarpal III of UF 256400.	337
Figure 87: Left Metacarpal IV of UF 256400.	342
Figure 88: Left Metacarpal V of UF 256400.	346
Figure 89: Left proximal phalanx of digit II of UF 256400.	350
Figure 90: Left proximal phalanx of digit III of UF 256400.	353
Figure 91: Left proximal phalanx of digit IV of UF 256400.	356
Figure 92: Left proximal phalanx of digit V of UF 256400.	359
Figure 93: Left medial phalanx of digit II of UF 256400.	362
Figure 94: Left medial phalanx of digit III of UF 256400.	365
Figure 95: Left medial phalanx of digit IV of UF 256400.	368

Figure 96: Left terminal phalanx of digit III of UF 256400. 372

Figure 97: Osteolytic and osseous cyst-like lesion features. 390

CHAPTER 1. INTRODUCTION

Terrestrial paleontological sites of the Hemphillian North American Land Mammal Age (NALMA), are rare east of the Mississippi River, and until the GFS was discovered, such sites were mostly known from Florida and Indiana (Farlow et al. 2001). Wallace and Wang (2004) initially suggested that the GFS dated between 4.5-7 Ma, placing the site in the Late Hemphillian. A recent revision, based on biostratigraphy, now estimates the GFS to be latest Miocene to Earliest Pliocene, near the Hemphillian and Blancan transition at about 4.9-4.5 Ma (Samuels et al. 2018), still within the initial 2004 estimation. With the GFS representing a forested refugium (Wallace and Wang 2004; DeSantis and Wallace 2008) in a time of changing environments, the site is critical to understanding late Hemphillian faunal diversity in the east.

A large Mammutid proboscidean was discovered at the GFS in Gray, Tennessee in 2015 although some ivory fragments belonging to this individual were initially found in 2000 by the Tennessee Department of Transportation. Numerous fossils were uncovered during road construction in 2000, which seven years later led to the re-routing of the highway and the construction of the East Tennessee State University and General Shale Brick Natural History Museum and Visitor Center at the locality (now the ETSU Museum of Natural History). Among the first fossils observed at the GFS were alligators (Schubert 2006; Schubert and Mead 2011) turtles (Clark et al. 2005; Bentley et al. 2011) tapirs (Hulbert Jr and Wallace 2011; McConnel and Zavada 2012) red pandas (Wallace 2011, Bristol's Red Panda; Wallace 2011, Red Panda), rhinos (Shunk et al. 2006; Wallace 2011, The Short-legged Rhinoceras), and proboscidean ivory and pes elements (Clark et al. 2005; DeSantis and Wallace 2008). Subsequent investigation of this area, beginning in 2015, produced a large, relatively complete Mammutid skeleton. As of the fall of 2018, virtually the entire individual has been recovered. To date, this individual is the only

complete mastodon discovered at the site, but other individuals are represented by isolated carpals, more ivory fragments, a second partial skull, and teeth, with some of the teeth even belonging to juveniles. Total number of GFS proboscideans is expected to increase with the continuation of excavations.

Mammut (Proboscidea, Mammutidae) is an elephantine relative that appeared in North America during the late Miocene and became widespread through the Pleistocene, with the American mastodon (*Mammut americanum*) being the most abundant and well-known species in North America (Saunders 1996). Fossil sites with *Mammut* species range from the Clarendonian to the Rancholabrean NALMA, with their disappearances coinciding with the megafaunal extinctions at the end of the Pleistocene (Fisher 1996; Saunders 1996; Polaco 2001; Feidel 2009). With the GFS acting as a possible refugium in a time of changing environments (Wallace and Wang 2004; DeSantis and Wallace 2008), and with the GFS proboscidean representing an early representative of *Mammut*, discovering what makes it different is crucial to understanding early *Mammut* species. As emphasized by Osborn (1936, 1942), proboscidean phylogenetics predominantly focuses on cranio-dental morphology. However, some comparative work has gone into post-cranial studies, focusing primarily on pelvis, limb bones, and vertebra (Olsen 1979; Haynes 1991, Hodgson et al. 2008, Larramendi 2016). This study is a description of the GFS mastodon manus with comparisons to a small gomphothere species, *Amebelodon britti*, *Mammuthus columbi*, and *Mammut americanum* mani from the Florida Museum of Natural History, ranging from the Hemphillian to the Rancholabrean North American Land Mammal Ages.

Background Review of Proboscidea and Mammut

Proboscideans are well represented in the fossil record due to their large and heavy-boned bodies that readily fossilize (Shoshani and Tassy 1996). Although proboscidean systematics are far from resolved (Lambert and Shoshani 1998), general trends have been noted. According to Shoshani (1998), by 1996 there were 352 recognized species and subspecies of proboscideans that were set into 44 genera and 8 families, which changed to 164 species and subspecies, 40 genera, and 8 families in 1998 through many revisions. Furthermore, Shoshani and Tassy (2005), with the addition of 13 new taxa, recognized 175 species and subspecies of proboscideans in 42 genera and 10 families. Though classification of Proboscidea will continue to change as more fossils are discovered, only three species from one family are extant: forest African elephant (*Loxodonta cyclotis*), bush African elephant (*L. africana*), and Asian elephant (*Elephas maximus*, with three subspecies) (Shoshani and Tassy 2005).

Proboscideans originated in Africa where the most primitive and smallest known proboscidean, *Eritherium azzouzorum*, was discovered in the Ouled Abdoun phosphate basin of Morocco (Gheerbrant 2009). *Eritherium azzouzorum* was about 20 cm. tall at the shoulder, weighed roughly 5 to 6 kg. (Larramendi 2016), lived about 60 million years ago in the Selandian stage of the Paleocene, and displayed early stages of many proboscidean characteristics such as: a primitive mammalian dentition with bunodont molars, signs of incisor reduction and the formation of lophodont teeth with transverse strips, a short mandibular symphysis, and far-forward positioned orbits (Gheerbrant 2009). In the same Moroccan phosphate bed, the Late Paleocene *Phosphatherium* was discovered in 1996, occurred 5 million years after *Eritherium* and displayed the “mastodont” tooth pattern (Gheerbrant et al. 1996). *Phosphatherium* was

slightly larger than *Eritherium*, having been about 30 cm. at the shoulder and weighing approximately 17 kg. (Larramendi 2016).

Early Eocene proboscideans, *Daouitherium* (from Morocco) and *Numidotherium* (from Algeria), had similar teeth to *Phosphatherium*, with *Dauitherium* displaying lophodont and bilophodont molars (Gheerbrant 2009). *Dauitherium* also continued the increasing size trend by weighing about 200 kg. (Larramendi 2016). Furthermore, *Numidotherium* had the mastodont characteristic of small tusks, a high forehead, and retracted nasal bones that indicate a short proboscis or trunk was present (Mahboubi et al. 1984). *Moeritherium*, discovered in Egypt, appeared in the late Eocene and Oligocene, had a short proboscis, primitive mastodont teeth, and short upper and lower tusks (Tassy 1995; Shoshani et al. 1996).

Although *Moeritherium* is not thought to be a direct ancestor to modern elephants, having been a proboscidean branch that died out with no descendants (Kappelman et al. 2003), Oligocene and Miocene radiations gave rise to proboscidean groups such as the deinotheres, amebelodonts, Mammutids, mammoths and modern elephants (Shoshani and Tassy 1996). Most phylogenetic studies place *Mammut* as separate from the stem-group of Proboscidea by 27 (Shoshani et al. 1996; Shoshani and Tassy 2005), which is also supported by genetic data (Rohland et al. 2007). Regardless of the phylogenetic structure, general trends in proboscidean morphology are evident in the fossil record. Most notable is an increase in size. At opposite ends of the size spectrum, tapir and hippo-like basal and early proboscideans were a meter or less in height at the shoulder, and a tall proboscidean from the middle Pleistocene, the steppe mammoth (*Mammuthus trogontherii*), was 4.5 meters tall at the shoulder (Shoshani 1998). Taller yet, *Palaeoloxodon* had a 5.2-meter-tall shoulder height (Larramendi 2016). Along with the increase in body size, there was an increase in proboscis length because with a reduction in the nasal

opening, the proboscis became larger and longer, developing into a “true trunk” (Mahboubi et al. 1984). Upper and lower incisors also elongated, exhibiting many tusk forms and shapes, whereas the teeth specialized from basal bunodont to cross-crested lophodont in *Mammut*, to the elephant and mammoth grinding lophodont teeth (Shoshani and Tassy, 1996).

Furthermore, the different proboscidean taxa can be categorized by trend radiations, which can also correlate with possible habitats (Shoshani 1998). Paleocene-Oligocene epochs (58-24 Mya.) exhibited the first radiation where all the African-origin proboscidean taxa had vertical tooth displacement (Shoshani 1998). These proboscideans had brachyodont, or low crowned teeth, and the upper third molar had three to four plates. Some of the first radiation taxa also had canines (Shoshani 1998). First radiation proboscideans were typically browsers (Shoshani 1998). A second radiation occurred in the early Miocene epoch when proboscideans spread into Eurasia once Africa connected via the Arabian Peninsula; and it was this radiation that brought about a horizontal tooth displacement, seen in the later *Mammut* and other proboscideans, caused by the mandible shortening to the point that the premolars and molars could not all be accommodated at once, leading to a “conveyor belt system” evolving (Shoshani et al. 1996; Tassy 1996; Shoshani 1998; Sanders 2018). Older, more worn, and smaller teeth get pushed out by the new, larger teeth in the back (Shoshani 1998). Teeth of the second radiation taxa were larger and had more transverse plates, ridges, and greater complexity (Shoshani 1998). Upper third molars in these taxa had up to seven plates and could be either brachyodont or hypsodont (Shoshani 1998). Second radiation taxa were mostly grazers (Shoshani 1998). A third and last radiation took place at the end of the Miocene, shortly after proboscideans crossed Beringia into North America during the middle Miocene (16 Ma.), and the third radiation trends are seen in the current taxa (Shoshani 1998, Tedford et al. 2004; Prothero et al. 2008). These

proboscideans differed in that their upper third molar had/has up to 30 plates, their teeth are complexly hypsodont, and are designed for heavy grazing for a grassy diet that is seen in today's *Elephas* and the past *Mammuthus* (Shoshani 1998; Green et al. 2017).

Mammut is related to Elephantoida (the mammoths and elephants), which it diverged from roughly 27 Mya, seen in Figure 1 (Rohland et al. 2007, Shoshani et al. 2007).

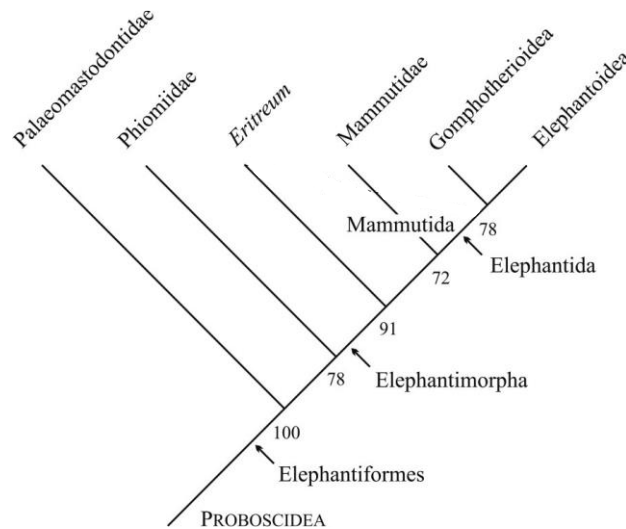


Figure 1: Proboscidean Phylogenetics (modified from Shoshani et al. 2007)

Mammut appeared during the late Miocene and greatly expanded with a distribution that covers much of Eurasia, all of North America and into Central America (Shoshani and Tassy 1996). In North America, many *Mammut* species also have been proposed. For instance, in North America, the most abundant *Mammut* is the American mastodon, *Mammut americanum*, which is one of the youngest species, along with *Mammut pacificus*, that appeared in early Blancan stage of the early to middle Pliocene (Saunders 1996; Dooley et al. 2019). However, *Mammut matthewi* from the late Hemphillian of the Snake Creek Formation in Nebraska is sometimes considered to be indistinguishable from the American mastodon. (Osborn 1936). Like *M.*

matthewi, another mastodon from the early to middle Pliocene Palomas Formation in New Mexico, *Mammut raki*, is also not distinct enough to be separate from the American mastodon (Lucas and Morgan 1999). There is also a *Mammut* species that has only been found in the Pliocene Coso Formation of California called *Mammut cosoensis*, which is debated as a new *Mammut* species (Shoshani and Tassy 1996). Other than the American mastodon which dominates North America, and extends into Central America, the other *Mammut* species are simply too scarce for a rigorous comparison of morphology, making the American mastodon the posterchild for *Mammut*. All further reference to mastodons will be based on the American mastodon.

Although not closely related, American mastodons are similar in many ways to mammoths and modern elephants. When compared to their other ancient relative, the mammoths, American mastodons were shorter in height but had longer, more muscled bodies and their skulls were lower and flatter (Larramendi 2016). Like mammoths and modern elephants, the females would be shorter and weigh less than the males (Larramendi 2016). Recent work also suggests that there was an indeterminate growth pattern in the tusks of American mastodons, so female tusks would not necessarily be smaller, slimmer in diameter, or less curved as previously thought (Smith and Fisher 2011). Social behavior for American mastodons and other *Mammut* are also interpreted to be similar to mammoths and modern elephants in that the sexually mature males appeared to live alone or in bachelor herds; females and juveniles consisted of a large social herd, led by an older matriarch (Haynes 1991), which relies heavily on modern elephant behavior and may not be justified in their extinct relatives.

Sexual dimorphism can be apparent in *Mammut* and the main difference between the sexes is maximum body size, with males typically attaining a larger size due to their lengthened

growth period. Maximum body size is reached nearly a decade after females (Hanks 1979). For instance, in modern African elephants, the male stands nearly a meter taller at the shoulder and generally weighs twice that of the female, and the adult males seen in the Hwange National Park in Zimbabwe are 20% to 40% taller and weigh 73% more than the females (Haynes 1991). Extra growing time to maturity, seen in males, is required for them to reach an advantageous size and learn competitive abilities that will increase their chances to breed; however, females stop growing early on so that they are ready for the reproductive development of a calf rather than continual growth of their own skeletons (Hanks 1979; Eltringham 1982). Additional evidence for determining the sex of a proboscidean is available through pelvic morphology. The main differences between female and male proboscidean pelvises is that the males have smaller pelvic apertures and broader illia than the females (Lister 1996).

Mammut tooth morphology and diet differed from members of the Elephantidae, which also lead to differences in preferred habitats. Mastodons had large zygodont teeth with sharp loph(id)s created by the anteroposterior compression of the molars, which transform the “central conules into sharp pretrite and posttrite crests” (Tassy 1995). *Mammut* molars were adapted to crushing woody and herbaceous browse material such as leaves, cones, twigs, and branches, suggesting many mastodons were forest dwelling browsers (Saunders 1996); however, the American mastodon was very successful from the Blancan to the Rancholabrean and inhabited all of North America, especially during the Pleistocene, when they expanded into Central America. While there is no record of the *Mammut americanum* in California, there are records of *Mammut pacificus* (Dooley et al. 2019). This wide expansion of *Mammut*, along with isotopic analyses and dental microwear textures, indicates that they occupied almost all environments that were available to them (Smith and Desantis 2018; Dooley et al. 2019). Despite

this success, the American mastodon was part of the Pleistocene megafauna extinctions about 12,700 years ago (Widga et al. 2017).

Gray Fossil Site

The depositional context of the GFS is a sediment filled sinkhole (4.7 Ma) dating to Hemphillian and Blancan transition located in Washington County, Gray, Tennessee (Figure 2) in the Knox Group Limestone (Wallace and Wang 2004; Samuels et al. 2018). GFS sinkhole may not be a single large sinkhole but a series of them, anywhere from seven to eleven, that formed independently but close together (Whitelaw et al. 2008, Zobaa et al. 2011). The site was discovered in 2000 due to roadwork that was intended to widen Route 75 at Fulkerson Road, which was then re-routed to preserve the site for excavation and future study (Shunk et al. 2006; Whitelaw et al. 2008). The current interpretation is that the sinkhole formed a pond that was a popular watering hole for the local fauna. This sinkhole gradually filled in with lacustrine sediment over the course of 4500 to 11000 years (Wallace et al. 2002; Wallace and Wang 2004; Whitelaw et al. 2008; Shunk et al. 2009).

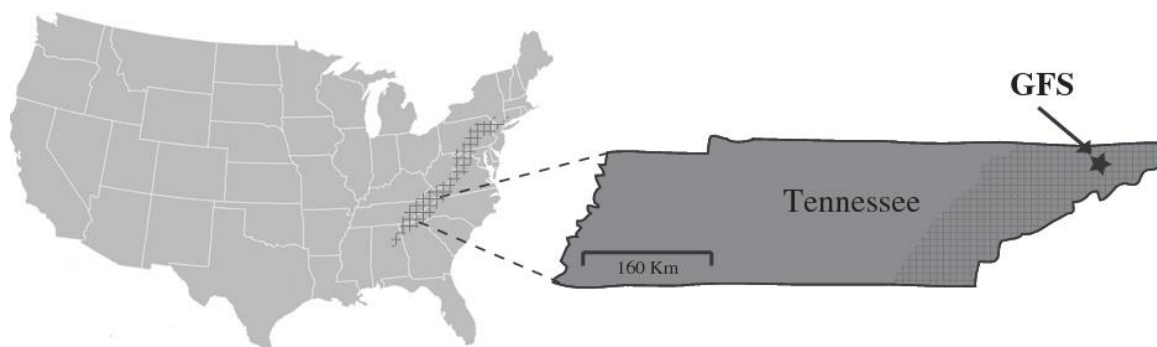


Figure 2: Gray Fossil Site within Tennessee. Modified after Shunk et al. 2006.

Estimated size of the sinkhole pond has varied over time with Wallace et al. (2002) estimating the deposit to be 1.8 ha and 35 m thick to later estimating the site to be 1.8-2.0 ha and 39 m thick (Wallace and Wang 2004). Shunk et al. (2006) originally estimated the GFS sinkhole to be 2.6 ha and 40 m thick but later adjusted the estimate to less than 2 ha and about 30 m thick (Shunk et al. 2009). Additionally, Whitelaw et al. (2008) estimated a maximum depth of 38 meters. Regardless of the variations, the surface areas remain small when compared to the volume, indicating that the pond was occasionally anoxic in deeper parts where little predation and disturbance could occur, allowing for remarkable preservation of GFS fossils (Shunk et al. 2009; Keenan and Engel 2017). Sedimentation fill-in created fine laminations with isolated coarse-grained sediments, creating the laminated facies and the graded facies (Wallace and Wang 2004; Shunk et al. 2006, 2009). Laminated facies occur at the surface between 504.8 and 502 m of elevation, and representing monsoonal precipitation patterns (Shunk 2006, 2009; DeSantis and Wallace 2008). Graded facies below 496 m contain dolomitic clasts and weathered quartz (Shunk et al. 2006).

Dominant flora at the site were *Carya* (Hickory), *Quercus* (Oak), and *Pinus* (Pine), with *Carya* and *Quercus* comprising 70% of the pollen assemblage, supporting the interpretation that the site was a permanent pond surrounded by a hickory and oak woodland (Wallace and Wang 2004; Olchoa et al. 2012). This enduring C3 forest refugium would have been present during the spread of the Miocene C4 dominant grasslands (Wallace and Wang 2004; DeSantis and Wallace 2008). Fauna consisted of both North American and Eurasian taxa, such as the North American *Teleoceras* (rhino) and *Plionarctos* (short-faced bear) and the Asian *Pristinailurus* (red panda) and *Arctomeles* (Eurasian badger) (Wallace and Wang 2004; Mead et al. 2012). Eurasian

lineages represent genera from cool climates, however the GFS also had warm climate genera such as *Alligator* and *Tapirus* (Wallace and Wang 2004; Mead et al. 2012).

CHAPTER 2. METHODS

Collection and Conservation

Excavation and conservation methods at the GFS are as follows: some of the proboscidean material was collected from the laminated beds in meter by meter gridded squares, but most of it was collected from rockfall deposits at the GFS with small, various hand trowels, carefully upturning the clayey soil by several mm (Wallace 2004). Bedding is disrupted by numerous boulders, which have been interpreted as the remains of a landslide, which occasionally required micro-explosives for removal. All excavated sediment was then wet screened with screening boxes made with 1.7 mm mesh (Boardman and Schubert 2011). Larger bones were hand-collected, their position surveyed with a Total Station and documented in the field, whereas small fragments were collected via wet screening. Elements were then cleaned via dry-brushing with a toothbrush, washed at a sink, and any concretion or other foreign material was removed with dental picks. Reconstruction was then conducted by the Haugrud and Compton method (2008) using Butvar-76 with an acetone solvent. The nearly complete and articulated proboscidean skeleton (missing only a patella, left fourth metacarpal, and some terminal phalanges) was excavated by the fall of 2018, and is still undergoing reconstruction; however, the near complete left manus of this study was already fully prepared and reconstructed by the beginning of 2018, before writing began.

The well preserved manus had very little fragmentation and any repair was made with Butvar-76 webbing as a filler, which is reversible (Haugrud and Compton 2008). All fragmented bone pieces were attached to the main element only if a contact point was available, and the reversible filler allows for the internal and/or connective webbing to be easily removed without harming the bone so that any additional fragments can be later added. No reconstruction was

done with MagicSculpt or aluminum mesh, so missing material is easily distinguished from filler and clear Butvar-76 webbing is acting as structural support. Since all the bones were reconstructed based on connection points, the morphology has no reconstructive bias.

Measurements and Photography

For every carpal, metacarpal, and phalanx in this study, the maximum width (medial to lateral), height (dorsal to ventral), and length (anterior to posterior) were measured with a sliding osteometric board. Accuracy was +/- 1 mm. Every other measurement, such as possible pathology sizes and articular facet surfaces were measured with a Fowler NSK Max-Cal 150 mm digital caliper. Caliper measurements were recorded to the nearest 0.1 mm. All manus measurements were taken three times to reduce errors and take a mean value, with +/- 0.5 mm measurement error being accepted. If the error was greater, measurements continued until accuracy was achieved. Additionally, photographs of the GFS and University of Florida (UF) specimens were taken using a Canon EOS Rebel Xsi camera, which was mounted on a tripod.

Museums and Species

The primary mastodon specimen is from GFS is in the East Tennessee State University Museum of Natural History (ETMNH) and is ETMNH 305. Comparative data was collected from the Florida Museum of Natural History (FLMNH) at the University of Florida. FLMNH taxa included: the American mastodon (*Mammut americanum*), Columbian mammoth (*Mammuthus columbi*), Britt's shovel-tusker (*Amebelodon britti*), and an unnamed species of small gomphothere. The small gomphothere was chosen to see how size affects the morphology of manus elements. The *Mammut americanum* (UF 137891) specimen is from the Late Pleistocene (Rancholabrean) and was found in the Bent Palm section of the Aucilla River in

northern Florida. The individual is thought to be female due to the small size of the ulna, humerus, and femur, which all have fully fused epiphyses, indicating the mastodon is also a full-grown adult. *Mammuthus columbi* (UF 256400) from UF is also Late Pleistocene (Rancholabrean) in age and was found at the Harrison Ranch Site in Hardee County, Florida. This individual is likely male based on the large femur size and the fully erupted M3 with medium wear. *Amebelodon britti* (UF 69997) was found at the Moss Acres Racetrack in Marion County Florida and is dated to the late Miocene (late early Hemphillian). The individual is believed to be an adult male based on skeletal size. Teeth sets had wear on the M2 with the M3 erupting representing a young adult. A small species of gomphothere (UF 423090) from the UF's Montbrook site in Levy County, Florida was included in this study, and it is from the very late Miocene (the latest Hemphillian). Sex is indeterminate and age is presumed to be adult, but the age qualifiers are unknown in this thesis. Chronological age, maturation status, and sex determination were provided by Dr. Richard Hulbert at the FLMNH.

Post-Cranial Comparisons

For this study, 25+ manus elements were included: carpals: cuneiform, unciform, magnum, lunar, trapezium, trapezoid, scaphoid, and pisiform; metacarpals: metacarpal I, metacarpal II, metacarpal III, metacarpal IV, and metacarpal V; most of the phalanges: 5 proximal phalanges respectively corresponding to the 5 metacarpals, 5 medial phalanges respectively corresponding to the 5 proximal phalanges, 1 terminal phalanx corresponding to the third medial phalanx: and various sesamoids. Manus elements are the focus here because they have been rarely used as post-crania for comparisons between proboscidean taxa and the manus looked like it had unusual carpal orientations. Furthermore, the left manus of the GFS mastodon

was chosen simply because it is the only completely prepped “foot.” For the UF specimens, some right mani were studied since they were available.

Abbreviations

Museums, Localities, and Others

Abbreviations: FLMNH, The Florida Museum of Natural History; GFS, Gray Fossil Site; ETNMH, East Tennessee State University Museum of Natural History Paleontology Collection at the Gray Fossil Site; UF, University of Florida Collection at the Florida Museum of Natural History; NALMA, North American Land Mammal Ages.

Articular Surfaces

Abbreviations: MC, metacarpal; PP, proximal phalanx; MP, medial phalanx; TP, terminal phalanx; ASC, articular surface for the cuneiform; ASC2, second articular surface for the cuneiform; ASC3, third articular surface for the cuneiform; ASC4, fourth articular surface for the cuneiform; ASP, articular surface for the pisiform; ASL, articular surface for the lunar; ASL2, second articular surface for the lunar; ASL3, third articular surface for the lunar; ASL4, fourth articular surface for the lunar; ASU, articular surface for the ulna; ASU2, second articular surface for the ulna; ASU3, third articular surface of the ulna; ASUN, articular surface for the unciform; ASUN2, second articular surface for the unciform; ASUN3, third articular surface for the unciform; ASUN4, fourth articular surface for the unciform; ASUN5, fifth articular surface for the unciform; ASS, articular surface for the scaphoid; ASS2, second articular surface for the scaphoid; PASS, proximal articular surface for the scaphoid; DASS, distal articular surface for the scaphoid; ASPDS, articular surface for the proximal surface of the distal scaphoid; ASDPS, articular surface for the distal surface of the proximal scaphoid; ASR, articular surface for the

radius; ASR2, second articular surface for the radius; ASM, articular surface for the magnum; ASM2, second articular surface for the magnum; ASM3, third articular surface for the magnum; ASM4, fourth articular surface for the magnum; ASPM, articular surface for the proximal magnum; ASAM, articular surface for the anterior magnum; ASDM, articular surface for the distal magnum; ASLM, articular surface for the lateral side of the magnum; ASPM2, second articular surface of the posterior magnum; ASAM2, second articular surface of the anterior magnum; ASMTDTM, articular surface for the magnum, trapezoid, and trapezium; ASTD, articular surface for the trapezoid; ASTD2, second articular surface of the trapezoid; ASPTD, articular surface for the proximal trapezoid; ASDTD, articular surface for the distal trapezoid; ASATD, articular surface for the anterior trapezoid; ASTM, articular surface for the trapezium; ASTM2, second articular surface for the trapezium; ASTM3, third articular surface for the trapezium; ASMC1, articular surface for metacarpal I; ASMC2, articular surface for metacarpal II; ASMC2(2), second articular surface for metacarpal II; ASMC2(3), third articular surface for metacarpal II; ASMC3, articular surface for metacarpal III; ASMC3(2), second articular surface for metacarpal III; ASMC3(3), third articular surface for metacarpal III; ASMC4, articular surface for metacarpal IV; ASMC4(2), second articular surface for metacarpal IV; ASMC4(3), third articular surface of metacarpal IV; ASMC4(4), fourth articular surface for metacarpal IV; ASMC5, articular surface for metacarpal V; ASMS1, articular surface for the medial sesamoid of digit I; ASMS2, articular surface for the medial sesamoid of digit II; ASMS3, articular surface of the medial sesamoid of digit III; ASMS4, articular surface for the medial sesamoid of digit IV; ASMS5, articular surface for the medial sesamoid of digit V; ASLS1, articular surface for the lateral sesamoid of digit I; ASLS2, articular surface of the lateral sesamoid of digit II; ASLS3, articular surface of the lateral sesamoid of digit III; ASLS4, articular surface of the lateral

sesamoid of digit IV; ASLS5, articular surface for the lateral sesamoid of digit V; AS1PP, articular surface for the proximal phalanx of digit I; AS2PP, articular surface for the proximal phalanx of digit II; AS3PP, articular surface for the proximal phalanx of digit III; AS4PP, articular surface of the proximal phalanx for digit IV; AS5PP, articular surface for the proximal phalanx of digit V; ASDMC1, articular surface to the distal surface of metacarpal I; ASDMC2, articular surface to the distal surface of metacarpal II; ASDMC3, articular surface to the distal surface of metacarpal III; ASDMC4, articular surface to the distal surface of metacarpal IV; ASDMC5, articular surface to the distal surface of metacarpal V; ASPMP2, articular surface to the proximal surface of the medial phalanx of digit II; ASPMP3, articular surface to the proximal surface of the medial phalanx of digit III; ASDMP3, articular surface to the distal surface of the medial phalanx of digit III; ASPMP4, articular surface to the proximal surface of the medial phalanx of digit IV; ASPMP5, articular surface to the proximal surface of the medial phalanx of digit V; ASDPP1, articular surface to the distal surface of the proximal phalanx of digit I; ASDPP2, articular surface to the distal surface of the proximal phalanx of digit II; ASDPP3, articular surface to the distal surface of the proximal phalanx of digit III; ASDPP4, articular surface to the distal surface of the proximal phalanx of digit IV; ASDPP5, articular surface to the distal surface of the proximal phalanx of digit V; ASTP1, articular surface for the terminal phalanx of digit I; ASPTP2, articular surface to the posterior surface of the terminal phalanx of digit II; ASPTP3, articular surface to the posterior surface of the terminal phalanx of digit III; ASPTP4, articular surface to the posterior surface of the terminal phalanx of digit IV; ASPTP5, articular surface to the posterior surface of the terminal phalanx of digit V; LSMC1, articular surface of the lateral sesamoid to metacarpal I; MSMC1, articular surface of the medial sesamoid to metacarpal I; ALSMC2, anterior articular surface of the lateral sesamoid for metacarpal II;

ALSMC3, anterior articular surface of the lateral sesamoid for metacarpal III; ALSMC4, anterior articular surface of the lateral sesamoid for metacarpal IV; ALSMC5, anterior articular surface of the lateral sesamoid for metacarpal V; MLSMC2, medial articular surface of the medial sesamoid for metacarpal II; MLSMC3, medial articular surface of the medial sesamoid for metacarpal III; MLSMC4, medial articular surface of the medial sesamoid for metacarpal IV; MLSMC5, medial articular surface of the medial sesamoid for metacarpal V; AMSMC2, anterior articular surface of the medial sesamoid for metacarpal II; AMSMC3, anterior articular surface of the medial sesamoid for metacarpal III; AMSMC5, anterior articular surface of the medial sesamoid for metacarpal V; MMSMC2, medial articular surface of the medial sesamoid of metacarpal II; MMSMC3, medial articular surface of the medial sesamoid of metacarpal III; MMSMC5, medial articular surface of the medial sesamoid of metacarpal V

CHAPTER 3. GRAY MASTODON OF THE GRAY FOSSIL SITE

Though only one associated skeleton has been discovered at the GFS, there is an assortment of unassociated material being excavated belonging to other individuals, raising the MNI to approximately 6 individuals. This unassociated material will not be addressed in this study considering how few specimens there are and the scarcity of other manus elements. The left manus (Figure 3), is the primary focus of this study to see how it compares to Florida proboscidean taxa from different North American Land Mammal stages. Left manus is missing the fourth metacarpal and four terminal phalanges.



Figure 3: Left Manus of ETMNH 305

Left Manus

Descriptive views follow Olsen (1979).

Carpals

Like other proboscideans, the GFS mastodon has 8 carpals in the manus. All 8 left manus carpals were articulated and associated with the left forelimb along with the rest of the skeleton.

Pisiform. This carpal (Figure 4) is the least complete. Pisiform connects with the cuneiform by a proximally oriented articular surface on the medial side of the bone and with the ulna by an articular facet on the dorsal surface. In this case, the pisiform is a partial carpal with only its ventral tip remaining, with an overall dorsoventral height of 85 mm, a greatest mediolateral width of 75 mm, and an anteroposterior width of 55 mm. Breakage is at a diagonal from the lateral side across and down into the medial side. Overall, the bone is pinched mediolaterally and tapers to a ventral tip. Looking at the pisiform in dorsal view, the spongy, cancellous interior is observable due to the breakage. In lateral, medial, posterior, anterior, and ventral views, the most notable features are the various blood vessel foramina and the shiny, fibrous webbing wrapping around the bone caused by soft tissue attachments. On the medial side, there is a slight raised line of bone separating the rugose ventral tip from the inward medial curving that would have been apparent underneath the medial side's proximal facet. The raised line stretches from the posterior to the anterior views. Medial curvature, near the dorsal breakage boundary, has a distinct change where the bone alters from the webbed rugose tip to the smoothness of the curvature. Only about 10 mm of the smooth bone surface remains from the transition to the breakage.

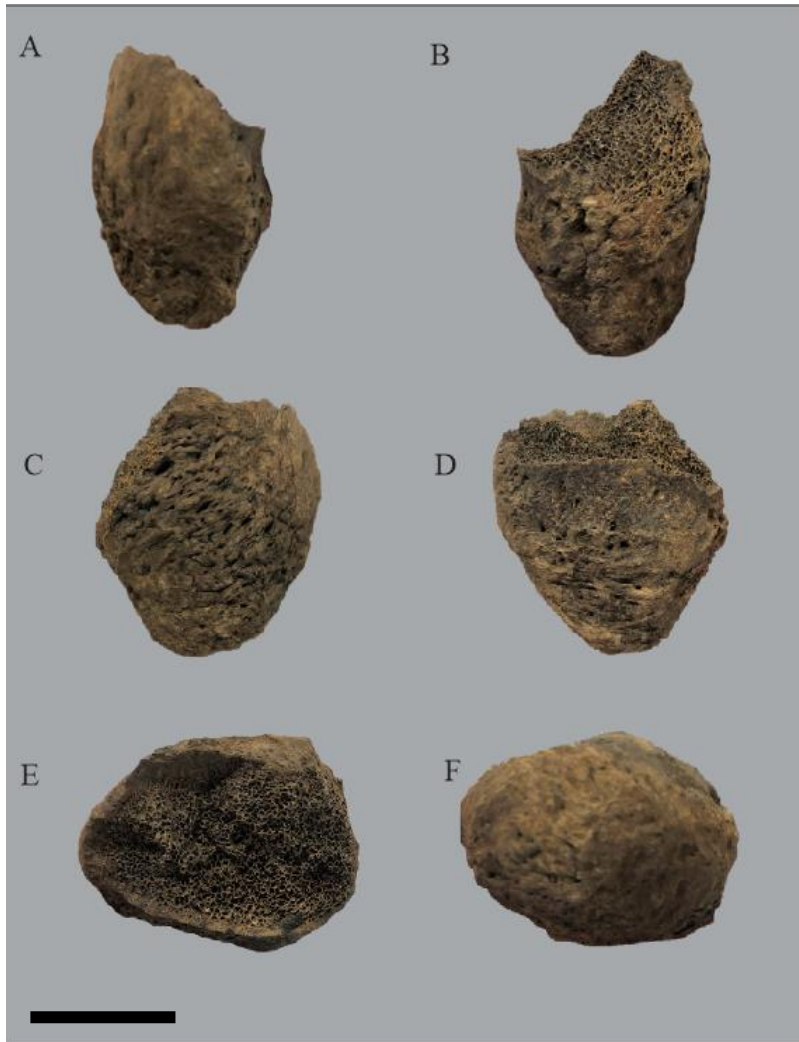


Figure 4: Left pisiform of ETMNH 305.
A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. Scale bar = 5 cm.

Cuneiform. The cuneiform (Figure 5) articulates proximally with the ulna, distally with the unciform, medially with the lunar, and posteriorly with the pisiform. Anteroposterior and mediolateral axes are long whereas the dorsoventral axis is short in comparison. Greatest dorsoventral height is 100.5 mm, greatest mediolateral width is 209 mm, and greatest anteroposterior width is 131 mm. It is almost entirely complete. In ventral view, it is missing a sliver of bone cutting across the unciform's articular surface shortly after where the surface begins to narrow into the cuneiform's lateral projection. The area of missing bone is also where the cuneiform has its greatest curvature. In posterior view, it is missing an approximate inch wide chunk of bone from the rugosely webbed lateral projection, midway between the end of the pisiform facet and the projection's point. Other than the missing bone fragments described above, ETMNH 305's cuneiform is relatively complete.

In dorsal view, the cuneiform is triangular shaped with the medial edge forming the base and the lateral projection tapering to the point. Anterior edge is very slightly concave, with the dip displaying where the articular surface for the ulna (ASU) ends and the rugose section of the lateral projection begins. Posterior edge is also inversely concave by comparison, though more so, with its greatest depression occurring at the same rugose to articular surface transition. Shape of the ASU is trapezoidal, with the greater base being the cuneiform's medial side, and the smaller base squarely rounds towards the lateral side as the lateral projection begins to taper and becomes rugose. ASU shares an articular edge with the articular surface for the pisiform (ASP) that is on the posterior side, and this shared edge has a circular, upraised bone growth, about 6 mm in diameter, midway along the conjoined boundary of the two articular surfaces. ASU is undulating, with the rise close to the anterior side and the fall towards the posterior, before it sharply rises again to the posterior edge. Also, two darkly stained areas in the center of the ulna

facet are slightly more porous than the rest, perhaps representing the beginning stages of an arthritic pathology where cartilage had begun to wear thin. Greatest mediolateral width of the ASU is 66.3 mm, and the greatest anteroposterior length of the ASU is about 52.2 mm.

In medial view, both the anterior and posterior curvatures of the cuneiform are convex. Anterior side is thicker than the posterior, and the ASU curves downwards into the cuneiform's medial side. This downward articular surface curvature is about 35 mm wide anteroposteriorly with a dorsoventral height of about 5 mm. Medial side has an anteroventral articular surface for the lunar (ASL) that is roughly oval shape. ASL tapers somewhat and terminates in the middle of the anteroposterior axis along the ventral edge, where the articular surface for the unciform (ASUN) borders. In greatest anteroposterior length, the ASL is 23.5 mm and the greatest dorsoventral height is 8.7 mm. There is a circular and bright stain in the center of the ASL that is somewhat porous, which could indicate that this part of the surface was where most of the movement took place.

In ventral view, the entire surface is the articular surface for the unciform (ASUN), except for where the rugose bone on the posterior side curves ventrally, making it visible on the ventral side. Shape on the ventral side matches the shape described for the dorsal view. Most of the central surface is smooth but the entire lateral projection is rough with a porous and rugose texture. Similar coarseness follows the anterior edge. Centrally bordering the anterior porous boundary, there is a dark stained oblong section with a depressed line transecting it. Rest of the surface is stained orange and has less wear.

In lateral view, most of what is visible is the rugose tip of the lateral projection. Some smaller foramina are also notable.

In anterior view, the ASUN edge has a generalized concave curve, and the ASU edge has an undulating contour. Entire anterior surface is rugose, though with less of a webbing appearance and more of a wrinkled, striated look, and foramina are visible throughout. Larger foramina are closer to the dorsal edge where a line of foramina are observed above the soft tissue striations. Although the general shape of the ASUN edge forms a concave curve for the bottom of the cuneiform, the articular surface is visible on the anterior side as it curves upwards and wraps anteriorly around in the lateral projection. There is a small knob of bone on the medial end of the cuneiform's anterior side where muscle attachment seems to have been prominent. There is also a crack cutting through the lateral projection mentioned previously.

In posterior view, the ASP is preserved and triangular. One side is the connected articular edge with the ASU and the other two sides slanting ventrolaterally into a rounded point along with the direction of the cuneiform's lateral projection. ASP is slightly concave in its center. Mediolateral width of the ASP is greatest on its dorsal edge, the same edge that is a shared articular surface with the ASU. Greatest mediolateral width for the ASP is 37 mm and its greatest length, from its ventrolateral to its dorsomedial extensions is 22.8 mm. Beneath the facet for the pisiform, there is a concavity of the bone where the cuneiform's lateral projection and pisiform facet act as the lateral and dorsal curvature. The depression is greatest in roughly the center of the mediolateral and dorsoventral axes. Two large nerve or blood vessel foramina can be seen at the greatest concavity point and two smaller foramina are visible dorsoventrally from the larger vessel openings. Depression lessens and terminates towards the medial side of the cuneiform where the bone then convexly bulges. On the lateral end of the cuneiform, where the projection curves posteriorly and rounds out, the bone has a somewhat shiny and rugosely webbed-like appearance, where soft tissue fiber attachments interweave.

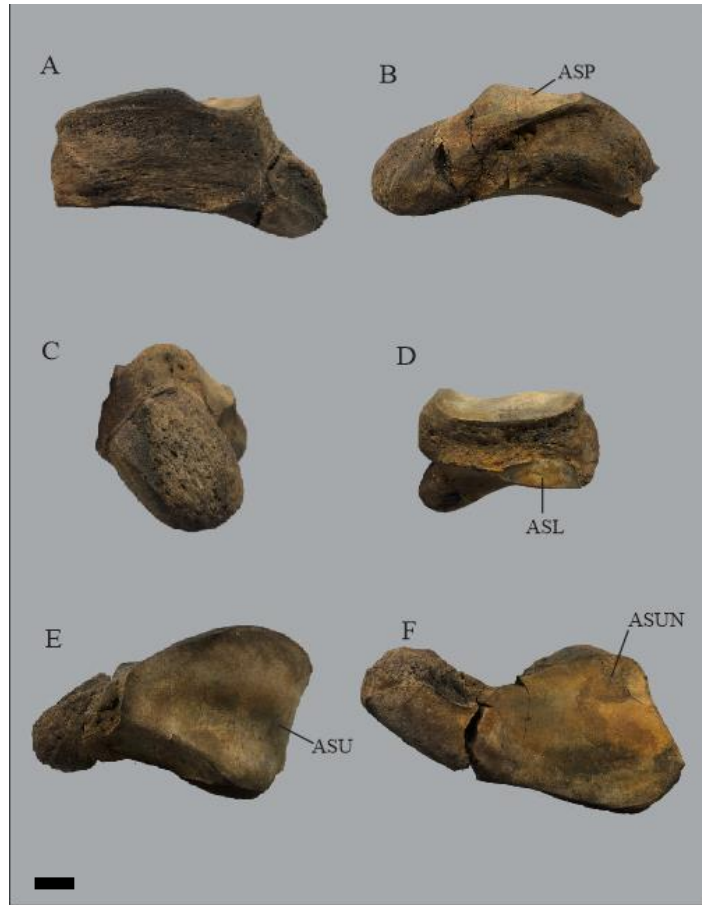


Figure 5: Left cuneiform of ETMNH 305.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASP, Articular Surface for the Pisiform; ASL, articular surface for the lunar; ASU, articular surface for the ulna; ASUN, articular surface for the unciform. Scale bar = 5 cm.

Lunar. The lunar (Figure 6) articulates proximally with the radius, dorsomedially with the ulna, medially with the cuneiform, distally with the magnum, and laterally with the scaphoid. Lunar is anteroposteriorly elongate with the anterior mediolateral length nearly matching the anteroposteriorly length as a whole, but the mediolateral length narrows significantly towards the posterior extremity. Lunar is dorsoventrally short. Greatest anteroposterior length is 155 mm, greatest mediolateral width is 151 mm, and greatest dorsoventral height is 91 mm. Lunar is very complete but because it was discovered broken into two pieces, there is an apparent crack that wraps around the entire anteromedial corner of the lunar. This breakage separated the articular surface for the cuneiform (ASC) and the ulna (ASU2) from the rest of the lunar until the Butvar-76 adhesive repaired the damage. The two largest missing fragments along the still visible crack are seen dorsally and medially. The dorsal missing chunk is in the center of the anterior curvature, and the medial missing rugose outer bone starts after the ASR and continues to the posterior point, exposing internal cancellous bone. Both missing bone fragments impede the rounded curvature of the ASR on both the anterior and medial sides. Lunar is very triangular and looks much like a large bike seat with the anterior edge making the base and the posterior side comprising the very rounded point.

In dorsal view, the anteromedial margin of the ASR is also the conjoined border margin for the ASU2. Anterior side is moderately straight whereas the lateral side exhibits a small concave curvature. Medial side has a greater concave curvature with the greatest depression occurring posteriorly to the dorsomedial ASU2. ASU2 itself displays a convex bulge into the medial side, and after the centromedial depression on the medial side, the bone curves into a convexly rounded posterior curvature. ASR is very smooth with no noticeable pathologies. Dorsomedially, the ASU2, which shares a border with the ASR, is quite large and slants

downward into the medial side of the bone. Center of the ASU2 has a slightly circular rise in its center. Furthermore, the ulna facet's dorsal ridge (which connects with the radius facet's medial ridge) has a small rise that extends into each facet. The raised bone extends into a little upraised ridge in the radius facet that follows along the anterior edge's curvature. The same small rise also seems to be a little more porous than the surrounding bone. Greatest width of the anteroposterior width of the ASU2 is 33.7 mm whereas its greatest dorsoventral height is 21.2 mm. The upwelling in the center is about 19.4 mm anteroposteriorly and has a dorsoventral height of about 15.2 mm. Along the circumference of the raised articular surface, the bone is more porous, especially along the dorsal portion, closer to the adjoining facet border and raised rugose bone. This area probably experienced more movement.

In medial view, there is an articular facet beneath the ASU2, which is the articular surface for the cuneiform (ASC). This is the distal facet in the medial view and is moderately flat. This ASC is 29.6 mm anteroposteriorly wide and 8.4 mm dorsoventrally tall. There is a light stain in the center of the ASC and a small, 1.5 mm bony growth towards its posteriorly tapering end. Area between the ASC and ASU2 is very concave, with the facets jutting out rather than gently curving outwards from the concavity. Many foramina are visible in the rugose concavity, which extends to the posterior point of the bone where it ends at a ball like nodule. The same happens as the concavity extends towards the anterior portion of the bone. In both cases, around the bulging protrusions, there is soft tissue striations and interwoven, fibrous, webbing. Missing medial chunk of bone previously mentioned is about 26 mm in anteroposterior length and is missing towards the posterior portion. On both the dorsal and ventral edges surrounding the articular surfaces, the outline of the bone in medial view is convex. Towards the posterior point, both ventral and dorsal sides become concave in contour. Anterior side is moderately flat with

little roundness except for the slight protrusion of the anterior bone nodule. Posterior point is very convexly rounded.

In ventral view, the articular surface for the magnum (ASM) takes up the entirety of the bone surface. It is greatly concave from the posterior point up to where the facets appear on the lunar's medial and lateral sides, which is where the rest of the bone up to the anterior side becomes convex. At the concave and convex transition, there is a subtle ridge of bone that cuts across the ASM, extending to the lunar's crack. This ridge is smooth compared to the surrounding bone and almost resembles another facet edge. Above this subtle ridge, just above where it begins on the lateral side of the bone, is a circular boney growth, about 1.87 mm in circumference. In the anterolateral corner of the bone, there is a smooth and darkly stained surface that extends from the outer lateral edge to the center of the bone. It is unlike its lighter and porous surrounding bone. Beneath the subtle transverse ridge, on the lateral side, there is a lighter section of bone, which also appears to be less porous than its surroundings that has a dark, raised bone growth of 1.47 mm in length. In the anteromedial corner of the lunar, there is a 3.5 mm long hole-forming pathology that narrows as it goes into the bone. The edges of the hole is very smooth.

In lateral view, the bone is relatively flush with the scaphoid's articular surfaces. Rugose bone between the lunar's scaphoid articular surfaces has very little concavity. Foramina are visible in the rugose center. A particular lumpy looking bone protrusion centrally located towards the posterior end of the rugose surface might actually be a bone growth. It is about 10 mm long and about 7.75 mm wide. And extends outwards from the bone by almost 3 mm. Soft tissue striations or webbing are not very noticeable until the posterior extremity. For the overall shape in the lateral viewpoint, the posterior end is convex and well-rounded whereas the anterior

end is undulating with the convex curvature occurring dorsally. Dorsal edge of the bone is concave whereas the ventral edge is concave from the posterior point to the beginning of the distal articular surface for the scaphoid (DASS), where the bone curves convexly from there to the anterior border. Proximal articular surface for the scaphoid (PASS) is long and thin. It is anteroposteriorly 33.8 mm long and about 5 mm in dorsoventral height in the center. It's greatest dorsoventral height, closer to the posterior end, is 6.1 mm. Proximal edge of the PASS, which conjoins with the lateral edge of ASR, seems to be worn down and porous. The facet rim is almost not even visible as it blends in with the ASR curvature. DASS is oval shaped and narrows posteriorly. It is mostly smooth with some porous edging and has a slightly raised center that is smoother without any porous appearance and is darkly stained. This articular surface is about 35.3 mm long anteroposteriorly and has a greatest dorsoventral height of 10.2 mm.

In anterior view, a crack runs down the dorsoventral center of the bone. It starts out as a ~3 mm crack ventrally, extends to ~6 mm crack in the center, and narrows again before flaring back out to a ~17 mm dorsally missing bone fragment. Anterior side is somewhat flat except for where a bony nodule extending anteriorly outwards on the lateral side. The ball like protrusion that begins on the lateral side lengthens towards to the center of the bone where it ends just after the central split. On the lateral side of the split, especially on the small protrusion, there is very apparent webbing. Medial side of the bone on the opposite side of the split does not have much apparent soft tissue attachment webbing. Ventral border of the anterior is mostly concave in shape whereas the dorsal border is mostly flat.

In posterior view, the point is very rugose with many foramina visible.

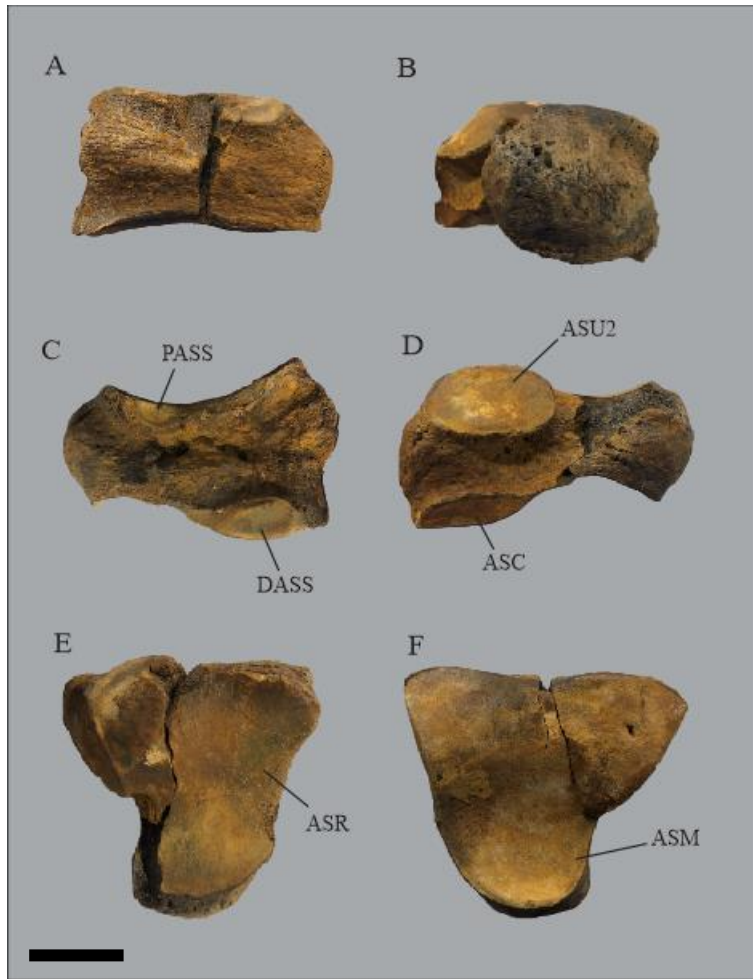


Figure 6: Left lunar of ETMNH 305.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. PASS, proximal articular surface for the scaphoid; DASS, distal articular surface for the scaphoid; ASU2, second articular surface for the ulna; ASC, articular surface for the cuneiform; ASR, articular surface for the radius; ASM, articular surface for the magnum. Scale bar = 5 cm.

Scaphoid. The scaphoid (Figure 7) articulates proximally with the radius, laterally with the lunar, and distally with the magnum, trapezoid, and trapezium. It is dorsoventrally and anteroposteriorly elongate but narrow mediolaterally. Its greatest dorsoventral length height is 145 mm; its greatest anteroposterior length is 126 mm; and its greatest mediolateral width is 67 mm. It is the most complete of the carpals with almost no missing fragments or cracks, having never been broken into multiple pieces. The only missing chips are from the articular surface rims and are not large enough to detract from shape or size. Like most of the other carpals, its general shape is triangular. It is a really well rounded, fat triangle, with the base being the ventral side and the point being the tip of the dorsal articular surface for the radius (ASR2); however, the dorsal facet makes a sharp diagonal in the triangular shape, making it look like part of the rounded anterior edge is cut off.

In dorsal view, the circular ASR2 is the most prominent observable feature, though the convex posterior edge and the extended distal articular surface for the lunar (ASL2) facet are also visible around ASR2. Dorsal articular surface for the radius has a conjoined rim that connects with the proximal articular surface on the scaphoid's medial side, which articulates with the proximal articular surface on the lunar's medial side. This conjoined articular surface is ASL3 and the shared border with ASR2 is porous and has a sharp rugose nodule at its apex. When articulated with the lunar, this nodule is visible above the contacting edge. ASR2 is moderately smooth and light but there is an area above the nodule where the bone is darkly stained and porous from possible wear. Greatest anteroposterior length of the ASR2 is roughly 42 mm and its greatest mediolateral width is 29.5 mm.

In medial view, three articular surfaces are visible: ASL2, ASL3, and the articular surface for the magnum (ASM2). ASL2 has a smooth center and is rimmed by porous bone. It has an

upwardly curved point that is depressed from the rest of the articular surface, making not only the smooth center but its surrounding porous bone, appear raised in comparison. Greatest anteroposterior length of ASL2 is 31 mm and its greatest dorsoventral height is 11.3 mm. Distal articular surface edge of ASL2 is shared by the medial edge of the articular surface for the magnum, trapezoid, and the trapezium on the scaphoid's ventral side (ASMTDTM). This shared articular rim is very porous from possible wear. ASL3 is slender and is a vertically lipped portion of the ASR2 on the medial side. The surface is smooth but with porous facet boundaries and is darkly stained from its center to its anterior termination. ASM2 is also mostly smooth but there is a porous and slightly raised boundary line that cuts through its anteroposterior center. Above the raised line, the surface is darkly stained. Its anteroposterior length is 36.2 mm and its dorsoventral height is 39.3 mm. There is a small concavity between the proximally located ASL3 and the distally located ASL2 and ASM2, which is rugose with many foramina. Distance between the articular surfaces, and thus the dorsoventral height of the concavity, is 26.2 mm. The concavity ends centrally with the appearance of a centrally and posteriorly oriented bone nodulation that is surrounded by very large foramina; however, the concavity does continue around the nodule and is at its greatest depression between the nodule and the ASM2. Additionally, there are two soft tissue attachment lines that are somewhat prominent towards the anterior, where the ridges meet almost at a point.

In ventral view, the ASMTDTM is most prominent but the curve for the posterior edge is also viewable along with the ASM2. ASMTDTM has its greatest anteroposterior length at 48.6 mm and its greatest mediolateral width at 34.7 mm. Articular surface is porous and slightly rough with the smoothest area being where the curvature to the ASM2 begins. Porosity is greatest, along with a dark stain, near the anterior edge.

In lateral view, the entire surface of bone is rugose and many foramina are observable. Most of the soft tissue striations seem to extend from a bony knot on the anterior edge and are either directed to the distal posterior corner or proximally, contouring the ASR2 rim.

In anterior view, the rounded anterior edge is all that comprises the scaphoid's anterior side. Part of the ASR2 is proximally apparent and there is an anteriorly expanded knot of bone beneath the rim of the ASR2. The knot has the usual fibrous and webbing appearance seen in other carpal bony knots. Rest of the bone is rugose with small foramina.

In posterior view, a large, convexly curved edge between the lateral and medial sides is all that is present. The bone nodule that was visible on the medial side is also noted here, extending medially. Rugose posterior ridge is entirely made up of shiny and fibrous soft tissue attachment threads, some webbed and some parallel. Posterior edge's greatest convexity is located near its ventral limit. Many small foramina are scattered about on this curvature.

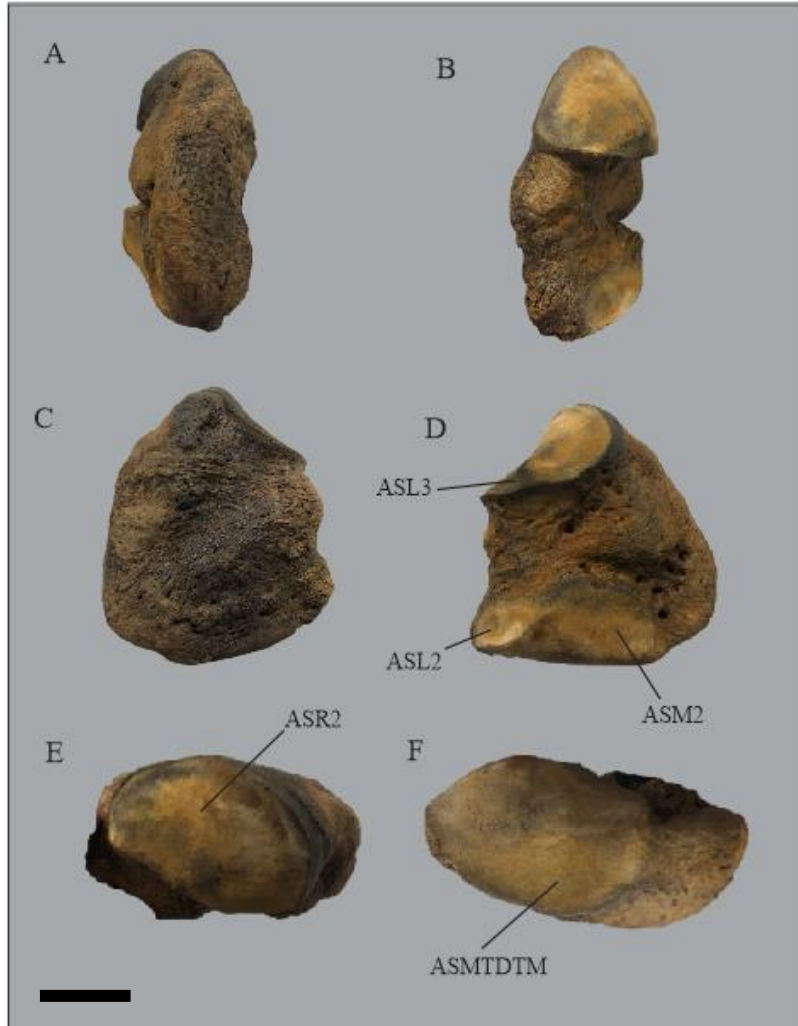


Figure 7: Left scaphoid of ETMNH 305.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASL2, second articular surface for the lunar; ASL3, third articular surface for the lunar; ASM2, second articular surface for the magnum; ASR2, second articular surface for the radius; ASMTDTM, articular surface for the magnum, trapezoid, and trapezium. Scale bar = 5 cm.

Unciform. The unciform (Figure 8) articulates proximally with the cuneiform, medially with the magnum, distomedially with the third metacarpal, distally with the fourth metacarpal, and laterally with the fifth metacarpal. Unciform is mediolaterally and anteroposteriorly elongate, and dorsoventrally shorter. Greatest mediolateral width is 155 mm, whereas greatest anteroposterior length is 151 mm, and greatest dorsoventral height is 110 mm. Unciform is largely complete except for various fragments that are missing at reconstruction sites in all views. The largest missing piece is on the anterior bone face and the next largest missing piece is on the ventral side. Due to the missing fragment on the ventral side, the interior of the unciform is visible. Where many articular and outer surfaces were reformed, some of the cancellous interior was unable to be pieced back together, which is only noticeable from the ventral side.

In dorsal view, the shape of the unciform is very square. Most of the dorsal side is the articulated surface for the cuneiform (ASC2), but there is rugose bone posterior to the ASC2, and the anterolateral corner is also a rugose nodule. Anterolateral corner is depressed from the ASC2 and has soft tissue webbing with small foramina present. ASC2's lateral edge is moderately straight but the articular surface exhibits a sharp concave curvature that steeply curves to the anterior edge when the anterolateral nodule is in contact. Once the concave curvature reaches the anterior side, it subtly rounds convexly outwards. ASC2 then curves a tight bend at the anteromedial corner and becomes moderately straight down the medial side until it gently rounds at the posteromedial corner. From there, the ASC2 has a slight undulatory curve on the posterior edge, with the convex portion taking up most of the posterior curvature before concavely connecting the posterolateral corner. ASC2 surface does not have much of an arch, but the greatest doming is posteriorly oriented. ASC2 is mostly smooth with much of the anterior edge being darkly stained and extra smooth. Section of posterior doming has a circular context to it

that is smooth but surrounded by stained and porous bone. This large area also has two chips in the bone. The first notch is more centrally located on the ASC2 and in the anterolateral section of the posterior circle. The second scrape is close to the ASC2's posteromedial corner as well as the posterior circle. The first chip is larger at about 2.66 mm in length and 1.8 mm wide and it has a straight edge with the chip depresses into. The second chip is shallower and is about 3 mm in length and 0.9 mm wide. The first chip is more grooved. Note, these were not made by the lab crew during reconstruction. Most likely, these were either somehow naturally there, or were caused by limestone chipping a long time ago during deposition. Staining is present in the more centrally located chip.

In medial view, the unciform is trapezoidal. The longer base is the rounded posterior side and the smaller base is the flat anterior side. Ventral side is convex and the dorsal side is mostly flat with the smallest doming present posteriorly. In the medial view, the articular surface for the magnum (ASM3) and the articular surface for the third metacarpal (ASMC3) are quite prominent. Dorsal edge of the proximal articular surface (ASM3), shares a conjoined facet border with ASC2's medial edge. ASM3 is long, broad, and flat with a concave ventral edge. Due to missing fragments, its anteroposterior length is approximately 60.9 mm and its greatest dorsoventral height is 30.3 mm on the posterior end whereas its minimal dorsoventral height, in the central area, is about 16.9 mm. Distal ASMC3 is long and slender. It is about 55 mm in anteroposterior length and its greatest dorsoventral height is about 24 mm. ASMC3 has a flat ventral edge but a convex dorsal curvature. Area between the ASM3 and ASMC3 is very concave and rugose with foramina. Fibrous webbing becomes visible closer to the rounded posterior side.

In ventral view, the unciform is very triangular, with the anterior side making the base and the posterior end comprising the point. Medial and lateral sides are slightly convex. Ventral articular surface is for the fourth metacarpal (ASMC4) and is missing many central bone fragments. Much of the articular surfaces appears porous, but this is mostly due to weathering rather than frictional wear. Central anterior area has dark staining and beneath the stain, there are two osteolytic features, which respectively are about 1 mm in diameter and the round edges are smooth.

In lateral view, the trapezoidal, like it is on the medial side. Similarly, the rounded posterior end is the longer base and the nodular anterior side is the smaller base. In this view, both the dorsal and ventral sides appear to concavely inwards. The articular surface on this side is for the articulation of the fifth metacarpal (ASMC5). Anterior and dorsal facet edges are straight whereas the posterior rim is convex and the ventral rim is concave. ASMC5 is very porous and has a distinct, raised ridge that cuts from the anterorventral corner and stretches into the middle of the articular surface. This raised and curved ridge is darkly stained and contours a similarly stained anterior, oval section, which is very smooth and without porous wear. There is a lighter stain more ventrally located that is similar smooth but does have some porous wear.

In anterior view, the bone is very rugose and has many foramina. Larger foramina are along the dorsal edge. Anterior side is moderately rectangular, and the lateral side has a prominent soft tissue attachment nodule. A large chunk of bone is missing in the ventromedial region and the missing section is approximately 19.5 mm mediolaterally wide and ~14 mm in dorsoventral height. For the most part, the anterior face is flat, with a slight curve as it bends towards the lateral nodule protrusion.

In posterior view, the unciform shape is triangular, with the base formed by the dorsal side and the point being the ventral and posterior rugose knot of bone. The entire side is rugose and many large foramina are scattered throughout. Fibrous soft tissue attachment webbing seems to sinuate the posteroventral nodule and stretches out over the rest of the bone surface.

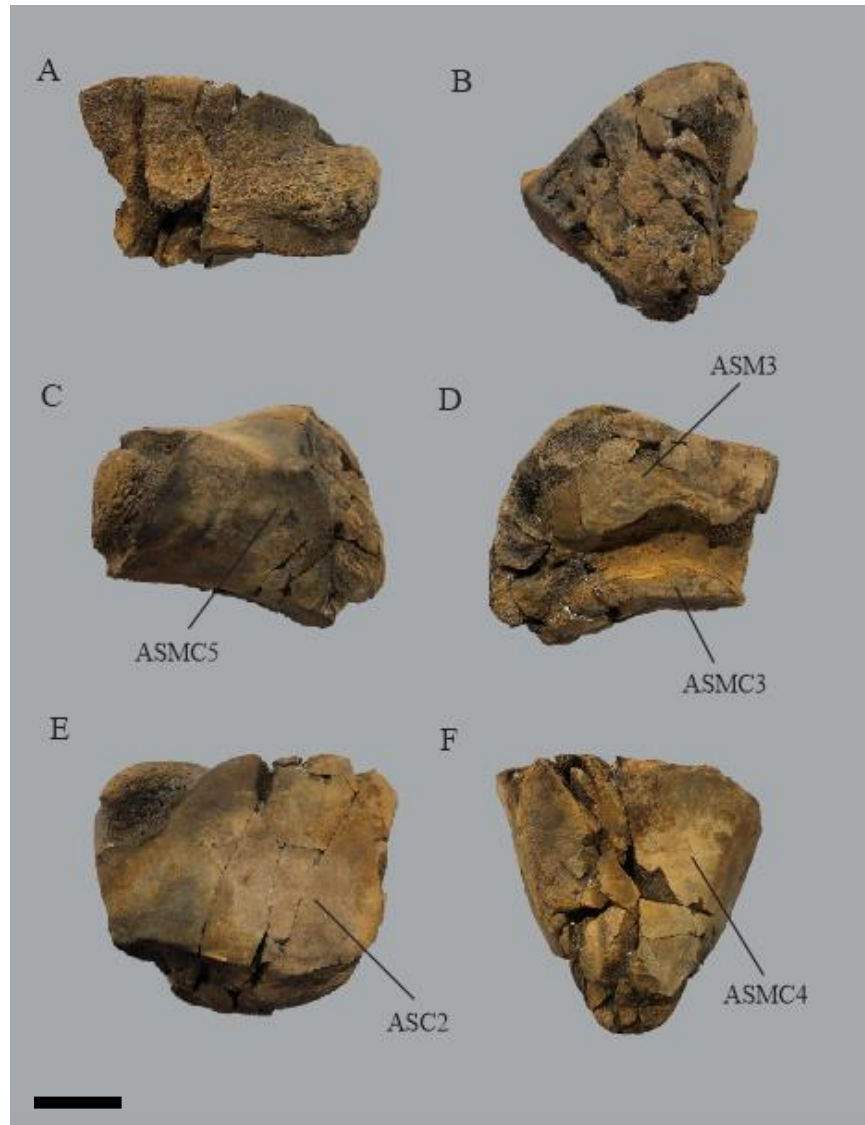


Figure 8: Left unciform of ETMNH 305.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASM3, third articular surface for the magnum; ASMC3, articular surface for metacarpal V; ASMC4, articular surface for metacarpal IV; ASMC5, articular surface for metacarpal V; ASC2, second articular surface for the cuneiform. Scale bar = 5 cm.

Magnum. The magnum (Figure 9) articulates proximally with the lunar, medially with the unciform, distally with the third metacarpal, and laterally with the trapezoid. Anteroposterior axis is the longest, followed by the dorsoventral, and the shortest axis is the mediolateral one. Greatest anteroposterior length is 144 mm; greatest dorsoventral height is 129 mm, and greatest mediolateral width is 120 mm. Overall magnum shape is square and blocky. Of all the carpals, the magnum is the least complete. Many bone fragments are missing, and the interior is largely absent, but all the bones pieces that are glued together in the reconstruction of the magnum are in actual position since they all have connections to each other, with no “floating” pieces present. For the missing interior surfaces that did not connect to anything, Butvar-76 structural webbing is utilized for support. Because of the prepping and reconstruction techniques, it is important to note that the apparent webbing holding the pieces of the magnum together are not a paleo-reconstruction or sculpt restoration. Missing pieces are simply absent with no inferred reconstruction present. All the existing pieces are in actual position and are merely held together with the structural stability of the webbing.

In dorsal view, the entire surface is comprised of the articular surface for the lunar (ASL4); however, there is a large section of the articular surface that is missing that stretches from the center of the dorsal face to the medial side. It is approximately 43 mm in length. ASL4 mostly flat, especially the anterior portion, but the posterior end does have slight doming. Medial side of the ASL4 is straight but the anterior edge has an undulating curve where it starts out curved anteriorly outwards on the medial side but begins a downward descent towards the lateral side. Likewise, the lateral edge is similar, but the concave curve begins at the anterior corner and curves into a convex contour towards the posterior corner. Posterior side is convex. Overall, the fragmented ASL4 is smooth with some porous wear along the edges. The small posterior dome

also has observable rubbing striations that run anteroposteriorly. In the center of the ASL4, there are two osteolytic features that are about 2 mm in diameter, and like the same features on the other carpals, the round edges are smooth.

In medial view, many missing fragments are noted, especially within the proximal articular surface, and the entire anterior side is absent. Shape in this view is trapezoidal, with the larger and rounded base being the posterior curvature and the anterior side would have comprised the other smaller and most likely flat base. Dorsal side is relatively flat whereas the ventral side has a concave curvature. Proximal articular surface (ASUN2) correlates with the proximal articular surface on the unciform's medial side. The smooth ASUN2 stretches from the anterior edge to the posterior edge and has a rounded posterior end, a concave ventral border, a flat dorsal border, and a missing, but presumably flat, anterior edge. Best approximation for the ASUN2's anteroposterior length, based on what is available, is 60.5 mm. Its dorsoventral height, taken where the only available dorsal and ventral connections are present in the middle of the ASUN2, is about 17.5 mm. For an approximate greatest dorsoventral height, where the rounded posterior portion of the facet is available, it is at least ~34 mm. The smooth distal articular surface (ASUN3) correlates with the distal articular surface on the unciform's medial lateral side. Like its proximal counterpart articular surface, it is also missing its anterior outline. ASUN3 is long and slender. It is also missing a bone fragment in the middle of the facet, but this gap is representative of the size and shape of the missing bone as those surrounding it are still in actual position since both sides of the gap are connected by the central rugose bone comprising the concavity between the two articular surfaces. Based on the articular surfaces present, the anteroposterior length of ASUN3 is 33 mm, but this articular surface would obviously be larger if the missing anterior fragment was available. Its preserved greatest

dorsoventral height is about 9 mm. The whole anterior portion of the magnum in medial view is broken off but much of the central concavity between the two facets is accounted for. Some foramina are in the concavity and the shiny interwoven rugose webbing appears in the bone closer to its posterior end where it spreads out to a semi-complete bony protrusion.

In ventral view, the articular surface is for the third metacarpal's dorsal articular surface, also ASMC3(2). ASMC3(2) is very missing several surface pieces of bone, mostly central and anterior sections. Shape of ASMC3(2) is difficult to distinguish but it looks like the medial and lateral sides are straight with a rounded posterior side. Anterior edge was probably straight as well. Most of the preserved articular surfaces are smooth but there is some frictional rubbing striations on the posterior end where the articular surface rounds out. Posterior to the facet is some of the rugose webbed bone that would have comprised a bone protrusion at the posteroventral apex. In ventral view, the articular surface for the second metacarpal (ASMC2) is also visible and this surface curves upwards towards the lateral side from the ASMC3(2). The conjoined border between the MC2 and MC3 is missing however. Both metacarpal surfaces are relatively smooth with little porous wear apparent.

In lateral view, the shape is trapezoidal like it is on the medial side. Unlike the medial side, there are three articular surfaces that are combined: the proximal, anterior, and ventral facets all connect. All three articular surfaces are missing their anterior ends and the anterior surfaces is missing much of its dorsal section. Proximal articular surface correlates with the proximal articular surface on the trapezoid's medial side (ASPTD). Likewise, this same pattern corresponds with the anterior and distal articular surfaces between the magnum and trapezoid resulting in ASATD and ASDTD. ASPTD's dorsal edge is flat, its posterior end is rounded, its central margin is concave, and its missing anterior edge was probably straight and flat. ASATD's

edges are all straight until they curve into their conjoined articular surfaces. ASDTD has a straight and flat dorsal edge, a convexly curved dorsal margin, a rounded and tapered posterior end, and a presumably flat anterior side. Surface of bone that is not articular is rugose and concave, with foramina. Large foramina are situated beneath the proximal articular surface. Furthermore, all the articular surfaces are smooth with porous edges. Also dorsolaterally oriented is the articular surface for the second metacarpal (ASMC2).

Facets on the lateral side are not complete, but the following measurements are based on what surfaces are present and thus do not represent maximal measurements. Anteroposterior length of ASMC2 is ~46 mm with an estimated dorsoventral height of ~15 mm. ASDTD has an anteroposterior length of ~39 mm. Its dorsoventral height on its preserved posterior section is 7.2 mm. ASATD'S anteroposterior length is 21.2 mm and its dorsoventral height is 86.7 mm. ASPTD'S anteroposterior length is at least 53 mm and its dorsoventral height at the posterior end, which is preserved, is 17.5 mm.

In anterior view, much of the front face of the magnum is missing. Only preservation present is that of the upper rim of the anterior side. The entire middle and interior of the anterior bone face is absent. Although bone is present on the ventral edge of the anterior face, it is broken enough that the outline is indeterminate. Upper anterior edge is slightly undulated, with the most outward or anterior convex curve being on the medial corner. The curve decreases into a slight concavity towards the lateral corner.

In posterior view, the magnum's shape is triangular. ASL4 makes the base and the posteroventral rugose apex becomes the point with the medial and lateral edges making slightly concave sides. Medial outline does have a greatly extended distal portion that is visible, somewhat distorting the triangular shape. ASL4 curves downwards into the posterior side, but

not much. Posterior apex of the ASL4 rounds out just off center on the more lateral side of the posterior surface. When the carpals are articulated, only the posterior point of the lunar surfaces covers the dorsal articulation that has curved into the posterior side. Corners of the dorsal facet are left uncovered by the lunar. Medial corner gets partially covered by the ventral cuneiform as it connects with the lunar and on the lateral side, that posterior corner gets covered by part of the scaphoid as it connects with the lunar. Beneath the ASL4 in the posterior side, there is a concave channel. The concavity ends where a small bony protrusion would have been at the posteroventral point. The bony projection's center and interior is missing with only its sides preserved. Within the concave channel above it, there are numerous foramina present with a few large ones standing out. One large nerve or vessel foramen is situated just above the missing projection's center. Posterior side is mostly rugose bone, besides the ASL4.

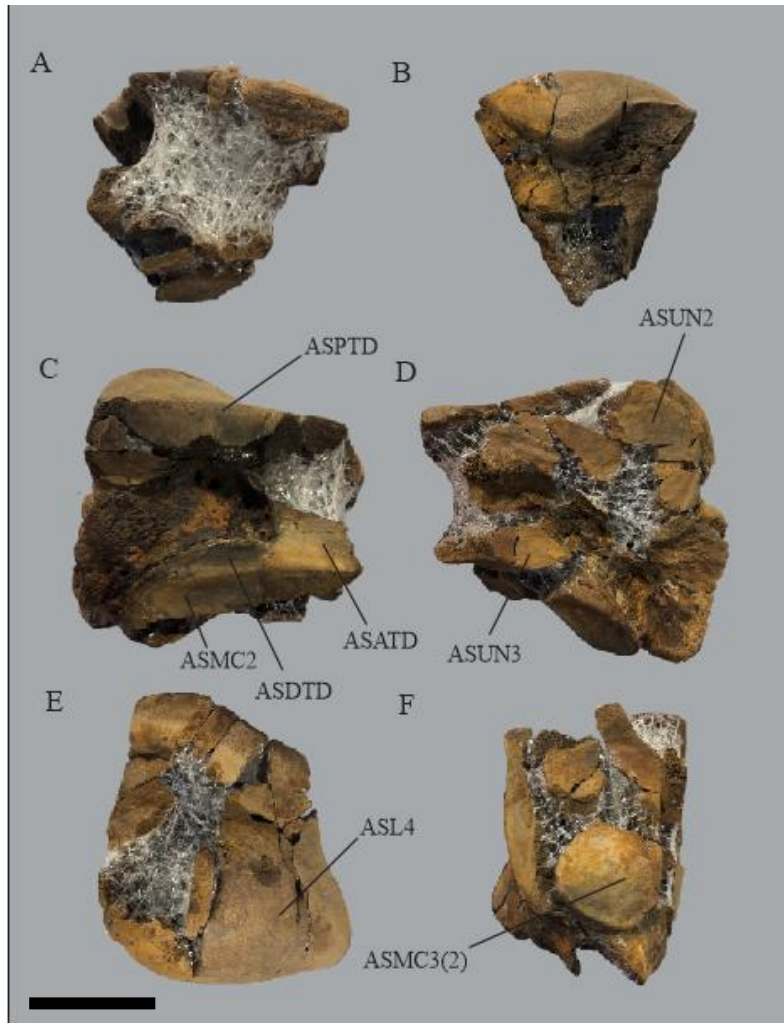


Figure 9: Left magnum of ETMNH 305.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASPTD, articular surface of the proximal trapezoid; ASATD, articular surface of the anterior trapezoid; ASDTD, articular surface of the distal trapezoid; ASL4, fourth articular surface of the lunar; ASMC2, articular surface for metacarpal II; ASMC3(2), second articular surface for metacarpal III; ASUN2, second articular surface for the unciform; ASUN3, third articular surface for the unciform. Scale bar = 5 cm.

Trapezoid. The trapezoid (Figure 10) articulates proximally with the scaphoid, medially with the magnum, distally with the second metacarpal, and laterally with the trapezium. It is anteroposteriorly elongate and both mediolaterally and dorsoventrally narrow. Greatest anteroposterior length is 127 mm; its greatest mediolateral width is 88 mm; and its greatest dorsoventral height is 68 mm. Trapezoid is almost entirely complete with very few chips or missing fragments. Like many of the other carpals, it is generally triangular in shape with the posterior end creating the rounded point and the anterior end forming the base.

In dorsal view, the trapezoid shape is triangular. Medial outline has an undulatory curvature from the anteromedial corner to the posterior point, with the convex portion anteriorly oriented and the inward curvature beginning in the center of the medial side and rounding out to the posterior point. Anterior edge is slightly concave with the small depression in the center. Lateral side is straight, and the posterior end is rounded. Most of the dorsal surface is comprised of the concave articular surface for the overlying scaphoid (ASS), except for some rugose posterior edge and the anterolateral corner also exhibits some of the rugose anterior surface. ASS therefore has a different anterior outline than the trapezoid as a whole, which is undulatory with the where the convex curvature is at the anteromedial corner and the concave curvature is at the anterolateral corner. The proximal articulated surface for the magnum (ASPM) on the medial side also curves into the dorsal plane and meets up with the ASS at an acute, raised point near the posterior end. Additionally, there is a posteriorly oriented rugose section of bone on the lateral edge that extends into the lateral side. ASS is smooth from its center to its anteromedial corner, though rimmed in porous bone, but the rest of the ASS is extremely roughly textured and porous. The coarseness is increased in two darkly stained spots. The first area is an oval section along the

anterolateral corner, and the second area encompasses the posterior end. The highly porous, rough and stained bone is slightly depressed from its lighter and smoother surroundings.

In medial view, the trapezoid is rectangular. Dorsal, anterior, and ventral sides are all flat and straight, but the posterior end has a rounded bell-shaped convex curvature due to a rugose nodule. There are also three different surface areas for articulation with the magnum's lateral side are combined into essentially one large articular surface: proximal (ASPM), anterior (ASAM), and distal (ASDM). ASAM is 31.8 mm in dorsoventral height, and with available but not maximal width, it is 16.6 mm anteroposteriorly wide. Anteroposterior length of the ASPM is at least 51 mm but a chip in the anterior-dorsal corner detracts a few mm of its actual size. Its central dorsoventral height, where the dorsal facet is at its minimum, is 9.9 mm. ASDM, based on what is present since there is a missing central chip, is 22.5 mm long anteroposteriorly and at least 6.4 mm in dorsoventral height. The rest of the bone is rugose, concave, and has foramina. All the articular surfaces are very smooth but rimmed by porous bone.

In ventral view, the trapezoid has the same shape as on the dorsal side. It is comprised entirely of the articular surface for the second metacarpal (ASMC2(2)). The articular surface is smooth except for pores visible along the anterior, medial, and lateral edges. Anterior, lateral, and posterior borders are also darkly stained. Lateral side's stain is between the lateral margin and a raised ridge in the articulated surface, and this stained region has the most porous bone from wear, hinting that darkly stained areas are places that the bones articulated with the most. ASMC2(2)'S greatest anteroposterior length is 52.9 mm and its greatest mediolateral width is 33.6 mm.

In lateral view, there is one most prominent articular surface for the trapezium (ASTM). Wedge-shaped ASTM extends from the anterior side and tapers to a dorsal corner near the

posterior end. Even in lateral view, the ASS is visible as it curves downward towards the lateral margin. ASTM connects with the ASS, sharing a border at the trapezium dorsal edge on the lateral side. ASTM has a smooth circular area in the center and the surrounding articular surface is darkly stained and porous. Anteroposterior width of the smooth circle is about 19.2 mm and its dorsoventral height is about 12 mm. The bone gets more porous and darkly stained as it reaches its posterior edge where it also has a small, rough rugose projection.

In anterior view, the trapezoid is triangular or wedge-shaped. Medial side makes the base and the anterolateral corner makes the point. Dorsal ridge is mostly flat, like the medial side, but the lateral and ventral sides comprise a convex curvature from the ventromedial corner to the anterolateral corner. The same curvature is also a raised ridge of rugose bone. Anterior surface is also slightly concave and rugose with some small foramina.

In posterior view, the rugose posterior tip forms a rounded, soft tissue webbed, protrusion. On either side of the knot, the medial and lateral sides are visible as they expand outwards. Above the center of the posterior nodule, there is the triangular point where the ASS and ASPM connect dorsally. The protrusion is riddled with foramina.

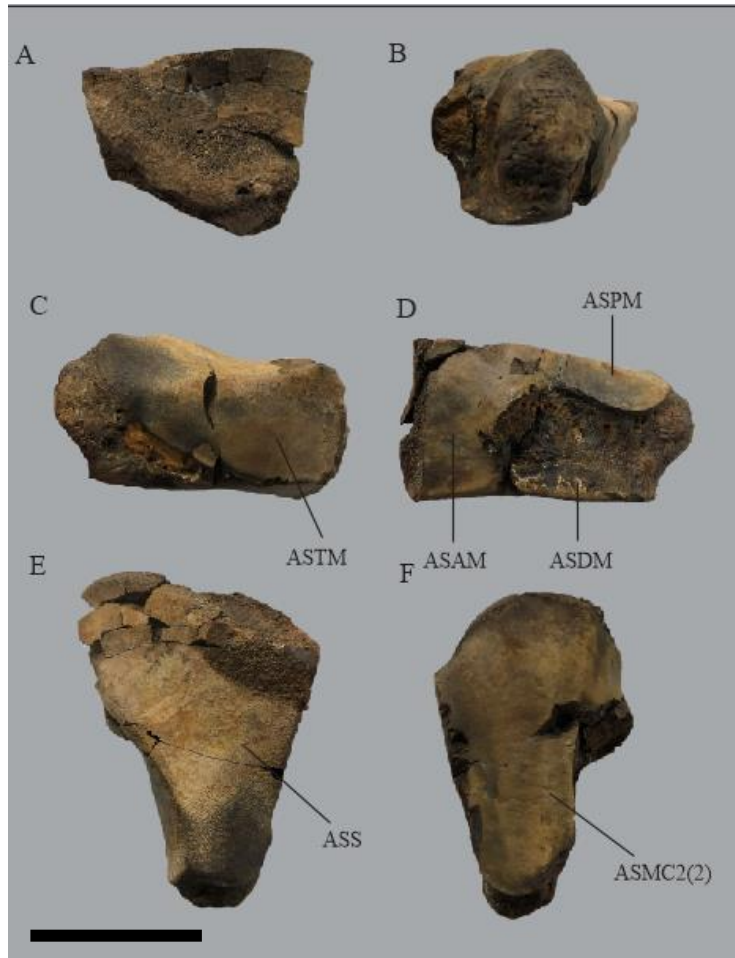


Figure 10: Left trapezoid of ETMNH 305.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASPM, articular surface of the proximal magnum; ASAM, articular surface of the anterior magnum; ASDM, articular surface of the distal magnum; ASTM, articular surface for the trapezium; ASS, articular surface for the scaphoid; ASMC2(2), second articular surface for metacarpal II. Scale bar = 5 cm.

Trapezium. The trapezium (Figure 11) articulates proximally with the scaphoid, medially with the trapezoid, and laterally with the first metacarpal. Mediolateral and dorsoventral axis are nearly equal in length and larger than the anteroposterior axis. Trapezium's greatest mediolateral length is 97 mm; its greatest dorsoventral height is 95 mm; and its greatest anteroposterior width is 70 mm. General shape of the trapezium is a cylinder. The trapezium is another nearly complete carpal but does have various cracks running around the surfaces and the largest missing chunk is on the anterior side.

In dorsal view, there is only one articular surface, which associates with the overlying scaphoid (ASS2). Medial edge is straight and the rest of the outline curves convexly into the rugose area. It is 31.0 mm anteroposteriorly length and has its greatest mediolateral wide at 16.1 mm. ASS2 is rough and covered in many tiny, porous rugose nodules. ASS2 is also lighter in color than the rest of the rugose bone. The rugose dorsal bone has a crack and various small foramina, along with a anterolateral nodule. The bone is concave along the ASS2's lateral contour.

In medial view, there is only the articular surface for the lateral side of the trapezoid (ASTD). ASTD dorsal's edge is straight, which is also the conjoined medial edge of the ASS2, and like the ASS2, the rest of the facet curvature is ventrally convex. ASTD has a smooth oval-shaped center surrounded by pores, and the ventral rim of the smooth center is upraised compared to the rest of the surface, which causes a slight depressed groove between the facet's edge and the porous rim outlining the smooth surface. The whole facet has an orange stain with lighter splotches mingled about. Furthermore, some pores, closer to the smooth center, have a dark circle encasing them. ASS2's overall anteroposterior width is 36.8 mm and its greatest dorsoventral height is 24.3 mm.

In ventral view, the rugose bone surface is relatively flat, with 3 small concave depressions, which look more like minor pits, closer to the lateral side. The largest depression is slightly anterior of the center and is the most concave, with a large foramen near its center. Posterior to the first, the second depression is the slightest in terms of concavity with foramina in it. Posterior to the second, the third depression also has prominent foramina within it. Only other foramina on the ventral side are along the posterior edge and ASTD border, which has a small concavity beneath its rim. Near the anterior border, the light fibrous soft tissue striations are curving over and are directed laterally. Likewise, striations near the posterior edge are at a parallel diagonal, seemingly directed centroventrally.

In lateral view, there is only the circular articular surface for the first metacarpal (ASMC1). ASMC1 is very round and is stained orange in its center. Anteroposterior diameter length is about 39 mm and 31.5 mm transversely. ASMC1's anteriorly rimmed border is raised, with the rest of the surface depressing slightly from it. Rest of the ASMC1's outline is mostly flush with the surface except for short segments along the dorsal and posteriorly ventral perimeters where the border actually depresses from the surface. Two obvious cracks cross the articular surface. Furthermore, the surface texture is similar to the ASS2 in that it has many rough and tiny rugose nodules. A raised rim in the articular surface is located anteriorly and is darkly stained from the rim to the border of ASMC1.

In anterior view, the rugose bone past the dorsal nodule dips into a circular concave depression, which rises back up and terminates near the anterior edge. Lateral risen edge of the concavity exhibits a heightened ridge where the glossy fibrousness is at its most apparent. Towards the ASTD, the bone continues to display the fibrous soft tissue striations, with some foramina throughout. Within the concavity, the fibrousness becomes more web-like. Foramina

encircle the depression. With the termination of the depression, the fibrous threading becomes lighter in color as it wraps around the anterior edge and into the ventral plane.

In posterior view, only a rugose edge is present as the dorsal portion of the trapezium curves into the ventral side. This edge has a concave hollow in its center, with the downward curvature starting beneath the ASS2's edge. Upward curvature begins towards the ASMC1. Thus, a small channel is seen in the posterior edge with foramina and parallel and cross-threading soft tissue attachments are observable.

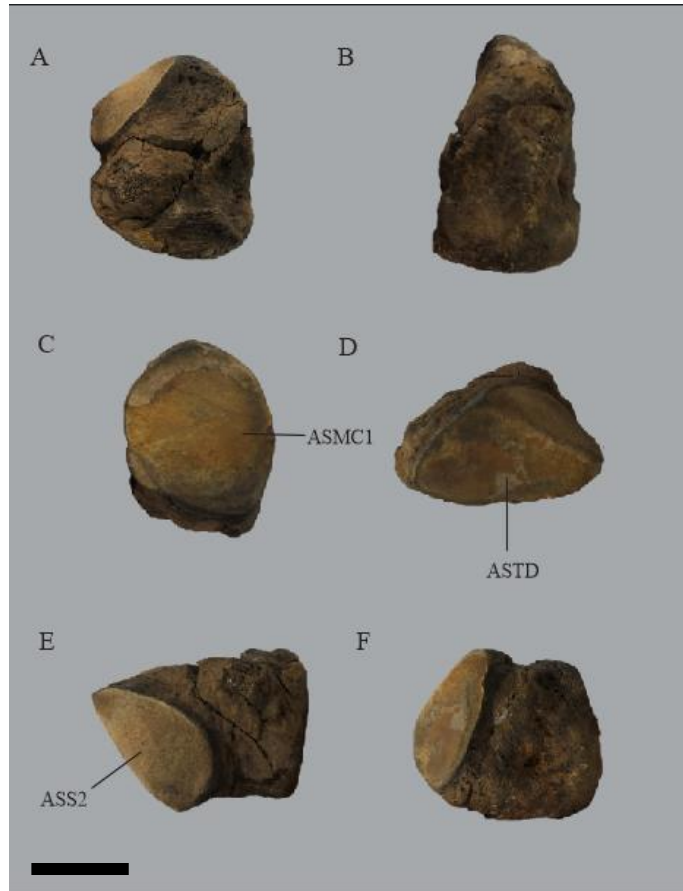


Figure 11: Left trapezium of ETMNH 305.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASMC1, articular surface for metacarpal I; ASTD, articular surface for the trapezoid; ASS2, second articular surface for the scaphoid. Scale bar = 5 cm.

Metacarpals

As is typical of other proboscideans, *Mammut* has 5 metacarpals in the manus. For ETMNH 305, only four of the five metacarpals were recovered. The fourth metacarpal is missing, but the rest of the metacarpals were found in articulation with the rest of the manus and skeleton.

Metacarpal I. The first metacarpal (MC1) (Figure 12) articulates proximally with the trapezium, and distally with the proximal phalanx for the first digit and two sesamoids. MC1 is dorsoventrally elongate, with narrow mediolateral and anteroposterior axes. Greatest dorsoventral length of MC1 is 135 mm; its greatest anteroposterior width is 82 mm; and its greatest mediolateral width is 78.5 mm. Due to missing bone fragments, the widths and height of the bone are not at their maximal proportions. MC1 is missing many large sections of bone but it is relatively complete. Both the proximal and distal articular surfaces have missing sections of articular faces and borders, and much of the cancellous interior is missing as well. Proximal posterior end and the distal lateral side of the MC1 shaft are also missing large areas of bone. Cracks and smaller missing fragments are seen around the rest of the MC1 shaft.

In dorsal view, rugose posterior bone, internal cancellous, and the articular surface for the trapezium (ASTM2), are observed. ASTM2 is anteriorly slanted and is in four pieces, resulting in a posterior, anterior, medial, and lateral piece. Each piece was reconstructed based on connection points. Preserved facet rims are present on the medial, anterior, and lateral fragments. From the available ASTM2 fragments, the mediolateral width is at least 28.7 mm, which isn't far from its actual width, and the anteroposterior length is at least 31.4 mm. The length is less than the actual maximum size by several millimeters due to the largely missing posterior end. Regardless of the missing posterior bone, there is enough of the outer bone shape that is

preserved to indicate that there was a posterior rugose projection pointing medially. Also, due to the three different facet rim preservations, the orientation of the ASTM2 is apparent and is not in line with the distal articular surface for the proximal phalanx of the first digit (AS1PP), unlike the other metacarpals. ASTM2 is approximately 45° medially oriented from its counterpart, AS1PP. Overall shape of the ASTM2 is indeterminate but it was most likely oval or circular.

In medial view, the anterior and posterior curvatures are concavely inward into the MC1 shaft. AS1PP is distally convex and the ASTM2 is slanted downwards towards the anterior side. There are two segments of missing bone, the first located in the center near the dorsal margin and the second in the center near the ventral outline. The entire medial side is rugose, especially along the ventral curvature where large foramina are present. Anteroposterior width of the ventral curvature is very large in comparison to the rest of the bone.

In ventral view, the AS1PP is the most prominent feature and is smooth but with a darkly stained center. Its greatest mediolateral width is 33 mm and its greatest dorsoventral length is about 25.8 mm. Curvature or ridge connecting the phalanx articular surface from the sesamoid surfaces is missing. AS1PP has some porous texture along its edges, and the edges are also raised above the articular surface, perhaps to limit the range of its proximal phalanx. Anteromedial rim has the most rough and rugose texture whereas the rest of the rim surfaces are smooth by comparison. Anteromedial rim is also the most raised facet border from the articular surface than the rest. Sesamoid surface, which is posterior to the AS1PP, is more porous.

In lateral view, the overall shape reflects that described for the medial side and the bone is rugose with no articular surfaces. Middle portion of the MC1 shaft is intact and exhibits a looks like it has a twisted appearance due to soft tissue attachments running from the posteroventral corner and up to the anterodorsal corner. Anterodorsal end has chunks of bone

absent as does the centroventral area. Some small foramina are seen along the ventral border and larger foramina are present along the dorsal border. The central bone has very little foramina present. Anteroposterior width of the ventral curvature is narrower than that seen on the medial side.

In anterior view, the medial, lateral, and ventral outlines curve concavely inwards and the dorsal outline slants from the dorsolateral corner down to the dorsomedial edge. The bone is rugose with numerous foramina present, with the larger foramina along the ventral edge. Missing bone fragments are seen on near the dorsal end, beneath the ASTM1, and extend from the medial to the lateral sides. Soft tissue striations run from the ventrolateral side and up to the dorsomedial side. ASTM1 curves up into the anterior view and its convex apex is off center, and more on the lateral side. From the apex to the ventrolateral corner, the rim is smooth, but from the apex to the ventromedial corner, the rim is rough and rugose.

In posterior view, the shape of the MC1 is reflected of that described in the anterior viewpoint. Posterior side of the MC1 is rugose except for the two ventral sesamoid articular surfaces. The same sesamoid articular surfaces are also visible on the ventral side, but their greater surface area is within the posterior plane where the curve up into from there connection with the AS1PP. There is a series of missing bone running down the center from the dorsal to the ventral edges. Ventral width is narrower than the dorsal width. Dorsolateral bone is forming the start of the posterior projection and has the soft tissue webbing on its surface, along with a foramen. A large foramen is seen above the articular surface for the lateral sesamoid (ASLS1). Ridge between the ASLS1 and the articular surface for the medial sesamoid (ASMS1) is missing but based on what is available, the ASMS1 is larger than the ASLS1. ASMS1 has a mediolateral width of about 13.7 mm and a dorsoventral length of about 26 mm. ASLS1 has a mediolateral

width of 11.5 mm and a dorsoventral length of 19.3 mm. Lateral medial margin for the ASMS1 is flush with the articular surface whereas the lateral margin for the ASLS1 is ventrally raised above the articular surface. No staining on the sesamoid surfaces is apparent.

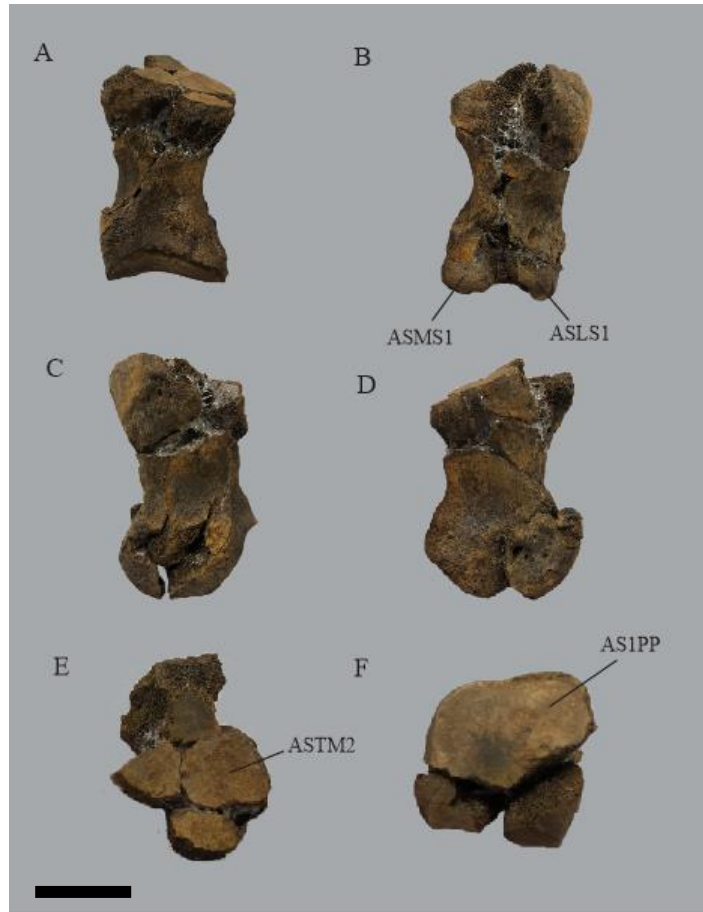


Figure 12: Left Metacarpal I of ETMNH 305

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASMS1, articular surface for the medial sesamoid of digit I; ASLS1, articular surface for the lateral sesamoid of digit I; ASTM2, second articular surface for the trapezium; AS1PP, articular surface for the proximal phalanx of digit I. Scale bar = 5 cm.

Metacarpal II. The second metacarpal (MC2) (Figure 13) articulates proximally with the trapezoid, dorsomedially with the magnum, medially with the third metacarpal (MC3), and distally with the proximal phalanx for the second digit (AS2PP) and two sesamoids. As a typical metacarpal, the MC2 is dorsoventrally elongate and mediolaterally and anteroposteriorly narrow. Greatest dorsoventral length is 210 mm; greatest mediolaterally width is 107 mm; and greatest anteroposterior width is 115 mm. Proximal anteroposterior width is larger than the distal anteroposterior width, which is 105 mm. MC2 is very complete, with only a few small chunks of bone missing and 2 semi-large pieces missing. The first larger missing piece is from the mid-shaft on the medial side and the second is from the ventral end to mid-shaft on the lateral side. No missing chips affect the maximal sizes of the MC2.

In dorsal view, the MC2 is moderately rectangular with the anterior and posterior ends curving convexly outwards and the medial and lateral sides slightly curving convexly inwards. Medial margin's concave curvature is so slight, it is almost straight. There are two articular surfaces that have a connective border. The more medial articular surface (ASLM) articulates with the distal articular surface on the lateral side of the magnum (ASMC2). The main dorsal articular surface (ASTD2) articulates with the trapezoid's ventral surface (ASMC2(2)). Connective articular margin between the two surfaces makes the highest dorsoventral point to this metacarpal. ASTD2 concavely curves to the lateral side whereas the ASLM concavely curves to the medial side. ASTD2 curvature is greater in depression than ASLM's curvature. Conjoined border starts in the anteromedial corner area and cuts across the dorsal face to end in the center of the posterior side. This shared border has the slightest laterally convex curvature to it and is almost straight. Because of the orientation of the shared border, the ASLM has an almost rectangular shape whereas the ASTD2 is larger and has a triangular wedge shape.

Anteroposterior length of ASTD2 is 50.3 mm, which is slightly less than maximum due to posterior chipping. Greatest mediolateral width, which is anteriorly located, is 34.1 mm. Both surfaces have smooth centers but very porous edges, with the connective edge being the most porous. No dark stains are noted. Anteroposterior length of the ASLM is 47.4 mm and the greatest width, anteriorly measured, is 11.4 mm. Lack of a posterior section for the ASLM decrease its anteroposterior length from its maximum, and the greatest mediolateral width would have been posteriorly located.

In medial view, the MC2 is moderately straight with almost no concave curve. Greatest concavity is seen just below the proximal articular surface (ASMC3(3)), which articulates with the proximal articular surface on the lateral side of the third metacarpal (ASMC2). Other than this articular surface, the MC2's medial side is composed of rugose bone with very few foramina visible. The concavity wraps around the ventral and posterior outline of the articular surface, and it has several foramina within. This articular surface is rectangular in shape and has a chipped dorsal border, a chipped partial posterior border, and it is missing a central and anterior fragment. The articular surface is slightly porous around its edges and the center looks smooth. Joined dorsal border of the ASMC3(3) and the medial border of the ASLM is more porous than the rest of the articular surfaces. Anteroposterior length of the ASMC3(3) is 39.9 mm, but this is less than actual maximum by a few millimeters. Dorsoventral height was taken at the posterior end where both the dorsal and ventral boundaries were preserved, and it is 15.7 mm. A small bony nodule about 13 mm below the ASMC3(3) has some of the soft tissue attachment fibrous texture that is seen at other rugose protrusions. This same texture is seen near the ventral curvature, but the shiny fibrous appearance is less webbed and more rounded here than seen in many other

areas. Also, there is a somewhat large piece of bone missing from the mid-shaft, with chipped surfaces extending towards the ventral curve.

In ventral view, the articular surface for the proximal phalanx of the second digit is the most prominent (AS2PP) feature. Anteroposterior length of the AS2PP is about 40.6 mm and the mediolateral width is greatest at 44.5 mm. Articular surface is very circular and light in color until a dark band of articular surface cuts mediolaterally across and separates the AS2PP from the articular surfaces of the medial and lateral sesamoids that are posteriorly located from the AS2PP. Mediolateral stain between the two articular surfaces is very smooth and creates a raised ridged within the AS2PP near its posterolateral limit, which probably limited the proximal phalanx from moving that far back laterally. Anteromedial articular rim is also raised above the articular surface, limiting movement beyond its point. As usual, the center of the AS2PP is smooth whereas its edges are porous. Articular surface makes a ridge that parallels the AS2PP's medial border and between it and the edge, the surface is darkly stained. The lighter articular surface is upraised from this dark edge. Posteriorly, a ridge begins that runs between the two sesamoid surfaces, with the medial sesamoid articular surface (ASMS2) being smaller than the lateral sesamoid articular surface (ASLS2).

In lateral view, there is no articular surface. The entire lateral side is rugose with various foramina observed. Dorsal edge is flat, whereas the anterior and posterior sides are concave, especially the posterior curvature. Ventral curvature is convex. There is a proximal concave depression that stretches anteroposteriorly, with large foramina. Posteroventral section is missing some bone, but anterior to the broken section, there is a subtle nodule of rugose bone with soft tissue attachments encircling it. The most apparent shiny fibrous and webbed bone is extending from the dorsally posterior edge down into the midshaft along the concave outline.

In anterior view, the medial and lateral sides are slightly concave, the ventral curvature is convex, and the dorsal outline is triangular due to the erected conjoined border of the ASLM and ASTD2. The ventral end has the AS2PP curving up into the anterior side, and along its anterior border is a parallel line of large foramina. Ventral width is also wider than the dorsal end, which tapers. Some cracks and chips are present on the anterior surface. Near the dorsal end, some small foramina are visible beneath the facet rim and there is the intercrossed fibrous appearance again, which looks more webbed on the subtly protruding dorsolateral corner.

In posterior view, the lateral and medial sides are concave and the dorsal end is narrower than the ventral end. Dorsal outline is indeterminate due to missing fragments and the ventral outline is centrally tipped in its convex curvature due to the raised ridge between the sesamoids. MC2's posterior side is rugose and foramina are few. The main feature is the distal medial and lateral articular surfaces for the sesamoids, which curve from the ventral view into the posterior side. Much of the articular surfaces are chipped away, especially for the ASLS2. The dividing ridge between the two surfaces is also largely absent and the entire bounding edges on the posterior side are gone. ASMS2 is at least 31.5 mm dorsoventrally long and at least 18.5 mm mediolaterally wide, and the ASLS2 is at least 20 mm dorsoventrally long and at least 21.5 mm mediolaterally wide. Articular surfaces appear porous, more so on the lateral side of the raised ridge between the two sesamoid faces. Medial sesamoid surface has a smoother center but due to missing fragments, its unable to be determined if the lateral face was similar. Area just above the sesamoid surfaces is very rough and pitted but smooths out as the center of the concave shaft is met. Some larger foramina are visible just above the sesamoid surfaces. Lastly, there is ridge of bone from the dorsolateral corner to the center of the MC2's posterior side, where soft tissue attachment fibers are directed. Near the dorsolateral extension of this ridge, webbing is visible,

which typically indicates a nodule. Since bone is missing in that area, the determination of a nodule is just speculation.

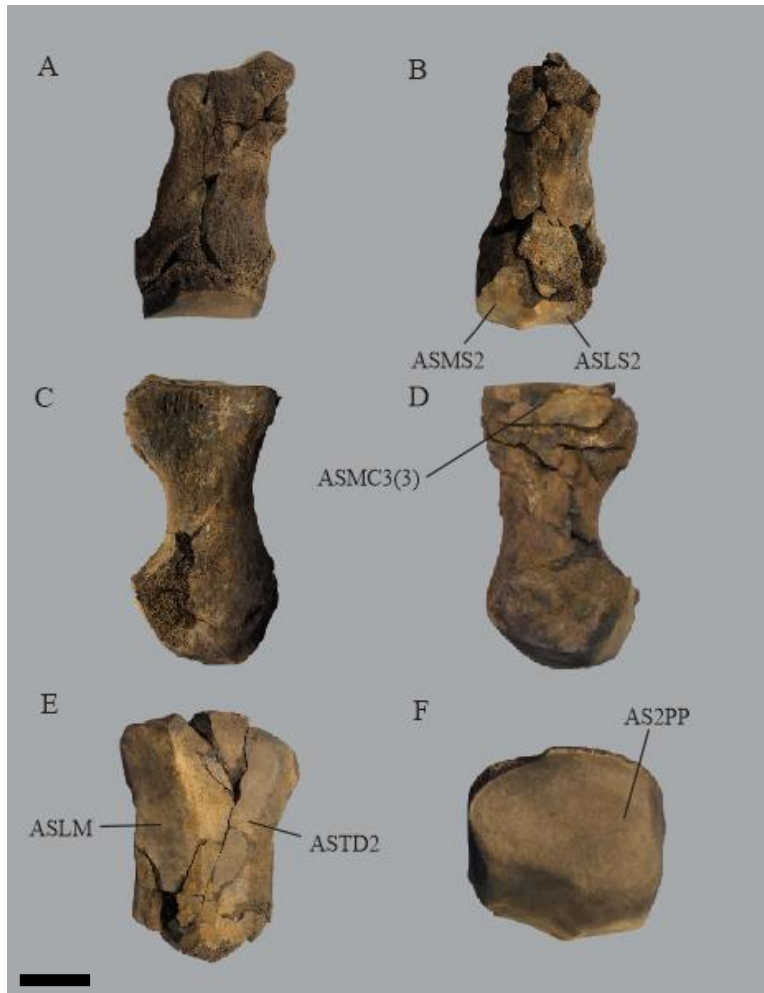


Figure 13: Left Metacarpal II of ETMNH 305.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASMS2, articular surface for the medial sesamoid of digit II; ASLS2, articular surface for the lateral sesamoid of digit II; ASMC(3), third articular surface for metacarpal III; ASLM, articular surface for the lateral side of the magnum; ASTD2, second articular surface for the trapezoid; AS2PP, articular surface for the proximal phalanx of digit II. Scale bar = 5 cm.

Metacarpal III. The third metacarpal (MC3) (Figure 14) is the largest metacarpal and it articulates proximally with the magnum, dorsolaterally with the unciform, medially with the second metacarpal, laterally with the fourth metacarpal, and distally with the proximal phalanx for the third digit and two sesamoids. It's dorsoventrally elongate and mediolaterally and anteroposteriorly narrow. Its greatest dorsoventral length is 231 mm; its greatest mediolateral width is 114 mm; and its greatest anteroposterior width is 119 mm, which is proximal. Maximal anteroposterior distal width is 109 mm. MC3 is the least complete with many Butvar-76 filled gaps, but enough of the external bone is available with connection points to retain the shape and size of the MC3. Its shape is very similar to the MC2.

In dorsal view, the shape is very triangular with the anterior edge making the base and the rounded posterior making the point. Much of the anterior end is missing and some of the posterior point is absent, but the medial and lateral outlines are very well preserved. Two articular surfaces encompass the dorsal surface. The largest is the articular surface for the magnum (ASM4), which articulates with the magnum's distal surface (ASMC3(2)). Its anteroposteriorly 53.8 mm long, and has a mediolateral width of 27.3 mm. Neither of those measurements are the maximal due to the anterior breakage. The other dorsal articular surface connects dorsomedially with the unciform (ASUN4), articulating with the distal articular surface on the unciform's medial side (ASMC3). Its anteroposterior length is 39 mm and it is mediolaterally 15 mm wide. Like the other articular surface, the length and width of ASUN4 are not maximal because of the missing anterior. Both of these articular surfaces share a conjoined border, which cuts a nearly straight line from the anterior side to the posterior. The connective margin is the highest point of the MC3 and is closest to the medial side, which increases the size of the ASM4 and decreases the size of the ASUN4. Both articular surfaces concavely curve from

their conjoined edge to their respective medial and lateral ones. Both wedge or triangle shaped articular surfaces are smooth and porous bone is not around the edges as is typical of the other metacarpals. ASM4 is very porous posteriorly, where the bone is also darker. There is another stain on this surface at the anterolateral corner, which remains smooth. Even the connective ridge is moderately free of porous bone.

In medial view, the anterior and posterior sides are concave, with the posterior outline more so. Both the dorsal and ventral curvatures are convex. Most of the bone is rugose, but there is a large proximal articular surface (ASMC2(3)), which articulates with the MC2. Although much of this facet is gone, what is available seems to indicate that the articular surface was large and oval shaped, which does not quite reflect the shape or size of the slender and rectangular articular surface that it articulates with. Based on what is present, the anteroposterior length is at least 30.5 mm and the dorsoventral height is at least 21.6 mm. Each of these measurements is far from maximal due to missing pieces. Preserved surface is smooth with no porous bone. Posterior border of the articular surface appears raised, perhaps to limit backwards sliding. Rugose bone beneath the facet rim is concave and has several large foramina. Distal rugose bone is smoother and dark.

In ventral view, the articular surface for the proximal phalanx for the third digit (AS3PP) is most prominent. Most of the surface is lightly colored but it is rimmed by a dark and smooth edge on every side except the most anterior. The dark edge is depressed from the rest of the surface, which is porous bordering the dark edge but smooth in the center. Greatest anteroposterior length of the AS3PP is 43.6 mm, and the greatest width is about 49.3 mm. Posteriorly, there is a dark ridge of bone that mediolaterally separates the AS3PP from the two posterior sesamoid articular surfaces. From this horizontal ridge, a vertical ridge bisects into the

posterior side of the MC3 to separate the medial sesamoid articular surface (ASMS3) from the lateral sesamoid articular surface (ASLS3). A small oval depression is at the horizontal and vertical ridge bisection point, and between this oval and mediolateral ridge to the raised AS3PP, there is a small concave channel in the dark and smooth bone.

In lateral view, the anterior and posterior curvatures are concave whereas the dorsal and ventral outlines are convex. Most of the lateral bone is rugose but there is a proximal articular surface, which articulates with the missing fourth metacarpal (ASMC4(2)). This articular surface is rectangular, long and slender. It is at least 41.2 mm in anteroposterior length and has a greatest dorsoventral height of 16.9 mm. Length could be less than maximal by a few millimeters due to posterior and anterior chipping of the articular surface. This surface is smooth with no porous bone or dark stains. Rugose bone is concave beneath the articular surface large foramina. There is also a smooth triangular nodule of bone anteriorly located beneath the articular surface. Distal rugose bone also becomes smooth and dark along the ventral contour.

In anterior view, the MC3 has the same shape as the MC2. It narrows proximally, with a wider distal end, and the surface is mostly rugose, with many large foramina located along the dorsal and ventral margins. Medial and lateral sides are slightly concave. AS3PP curves up into the anterior plane and the ASM4 curves down into the anterior plane.

In posterior view, much of the rugose shaft is missing and the proximal posterior point is very chipped. Medial and lateral sides are slightly concave and the ventral outline is convex with a central point caused by the ridge between the medial and lateral sesamoid articular surfaces. Dorsal, medial, and lateral facet margins are lost in posterior view but some of the sesamoid surfaces remain. ASMS3 is at least 30.3 mm dorsoventrally long and 21.8 mm mediolaterally wide. ASLS3 is at least 29.1 mm in dorsoventral length and is 20.4 mm mediolaterally wide.

Widths were taken close to the border with the AS3PP so they are not the maximal widths, and the lengths are not maximal due to the surrounding breakage. There surfaces are mostly light and smooth with some porous edging.

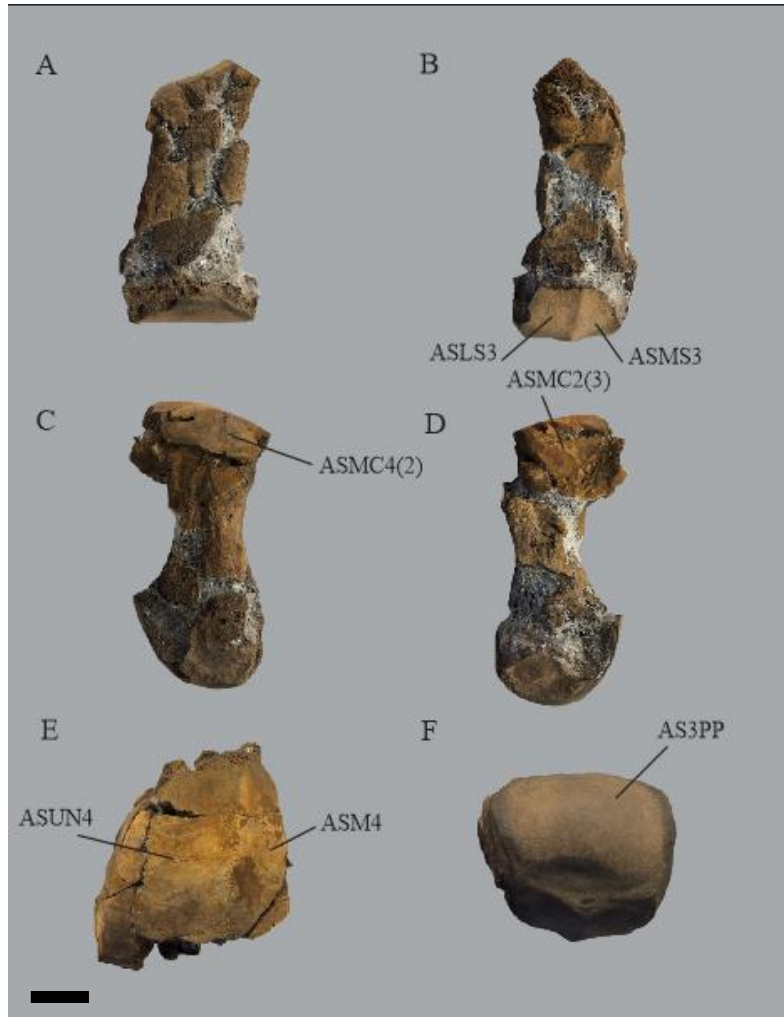


Figure 14: Left Metacarpal III of ETMNH 305.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASLS3, articular surface of the lateral sesamoid of digit III; ASMS3, articular surface of the medial sesamoid of digit III; ASMC2(3), third articular surface for metacarpal II; ASMC4(2), second articular surface for metacarpal IV; ASUN4, fourth articular surface for the unciform; ASM4, fourth articular surface for the magnum; AS3PP, articular surface for the proximal phalanx of digit III. Scale bar = 5 cm.

Metacarpal V. The fifth metacarpal (MC5) (Figure 15) articulates proximally with the unciform, medially with the fourth metacarpal, laterally with the cuneiform, and distally with the proximal phalanx for the fifth digit and two sesamoids. MC5 is dorsoventrally elongate and mediolaterally and anteroposteriorly broad. Its greatest dorsoventral length is 162 mm; its greatest anteroposterior width is 110 mm; and its greatest mediolateral width is 101 mm. MC5 is the most complete metacarpal, having only a few hairline cracks.

In dorsal view, the shape of MC5 is triangular with the anterior side forming the base and the posterior edge making the point. Three articular surfaces are visible. The main feature is the articular surface for the unciform (ASUN5), which articulates with the unciform's articular surface on its lateral side (ASMC5). ASUN5's greatest anteroposterior length is about 47.1 mm, and its greatest mediolateral width, located anteriorly, is about 34.9 mm. Shape of the ASUN5 is trapezoidal, with the anterior side making a flat base, the medial and lateral edges making straight sides, and the posterior edge making a slanted or diagonal smaller base. The diagonal starts at the posterolateral corner and slants upwards to the rounded edge of the posteromedial corner. ASUN5 is very smooth anteriorly, where there is a dark, circular stain. In fact, there are three different dark, circular rings that expand after each other. These areas are smooth but the rest of the surface is rugose and porous. Articular rims around the staining are upraised whereas the articular rims for the rest of the coarse surface depress from the remaining articular face. Articular surface for the fourth metacarpal (ASMC4(3)), though on the medial side, extends outwards enough that it is visible in dorsal view. A similar outward extension occurs for the articular surface for the cuneiform (ASC3), which is on the lateral side but is still visible dorsally.

In medial view, the ASMC4(3) is the most notable feature whereas the rest of the bone is rugose with various foramina. ASMC4(3) is rectangular, making it long and slender. Articular surface is smooth in the center, where it is a darker brown, and the edges are somewhat porous. Greatest anteroposterior length is about 41.6 mm and its greatest dorsoventral height is about 13.8 mm. Anteroventral portion of this facet appears to be slightly curved upwards to make room for the small rugose nodule beneath it. Anterior and posterior outlines of the MC5 are almost equally concave, and there are larger foramina visible dorsally and ventrally along the contours. Ventral curvature is convex and the dorsal outline is moderately straight across from the anterior to the posterior edges. Dorsally, the soft tissue webbing appears to sinuate the anterior knob, and ventrally, the fibrousness is more vertically oriented. Lastly, some webbing also seems to point towards a knob that is protruding from the posterior side but makes a curve on the dorsoposterior area.

In ventral view, the articular surface for the proximal phalanx for the fifth digit (AS5PP) is most prominent, and the two articular surfaces for the sesamoids are visible posterior to it. The sesamoid surfaces extend into the posterior view whereas the phalange curve extends into the anterior view. AS5PP has a greatest anteroposterior length of about 43.3 mm and a greatest mediolateral width of about 46.9 mm. Much of its surface is rough with porous and rugose nodules and the large, circular center is upraised from the rest of the articular surface. The depressed rimming is typically darkly colored and about 5 mm wide all the way around. There is a concave mediolateral line that separates the AS5PP from the sesamoid articular surfaces. Dark triangular shaped surfaces are on the medial and lateral sides and their points become the connecting ends of the concave line separating the AS5PP from the sesamoid surfaces. The triangles are upraised from the rest of the surface.

In lateral view, there is a small articular surface for the cuneiform, or ASC3. This articulates particularly with the cuneiform's ventral section of its lateral projection. ASC3 is about 27.9 mm anteroposteriorly long and has a greatest dorsoventral height of 15.8 mm. The entire surface is rough and with many small nodular projections. Anterior and posterior sides appear more concave in this view than they did in the medial viewpoint. Ventral contour is convex and the dorsal outline is moderately straight and slanting from the anterior side down to the posterior. Beneath the proximal articular surface is a large rugose nodule and ridge. Foramina are visible throughout the rugose bone and are larger in the nodule and ridge.

In anterior view, the medial and lateral sides are slightly concave whereas the ventral contour is convex and the dorsal contour is mostly concave. The entire surface is rugose except for the small distal section where the AS5PP curves up into the anterior plane. The proximal area is rugosely extended, causing a concavity in the anterior's center mediolaterally. Foramina are scattered throughout but are larger in the proximal extension and along the outline of the AS5PP. Anterior rim of the AS5PP seems to be raised above the articular surface to limit its anterior range of motion. Soft tissue webbing attachments are most prominent at the anteromedial corner.

In posterior view, the medial and lateral sides are slightly concave and the dorsal outline is flatly slanted from the dorsolateral corner to the dorsomedial. Ventral outline is convex with the ridge between sesamoids forming its apex. Most of the posterior bone is rugose and there is a mediolateral concavity in the center. ASC3 extends into this side near the dorsolateral edge and the sesamoid facets curve into this side from the ventral edge. A bony protrusion posteriorly extends to a point in the dorsomedial area, and this nodule has a lot of soft tissue attachment scarring. Large foramina are in the dorsal portion and some other smaller foramina are in the center and along the sesamoid facet rims. There is a raised rim on the articular surface between

the lateral and medial articular sesamoid surfaces (ASMS5 and ASLS5). This elevated ridge is closer to the medial side, making the ASLS5 larger than the ASMS5. Greatest dorsoventral length of the ASMS5 is about 25.5 mm and its mediolateral width is about 14.2 mm. Width could be a few millimeters less than maximal due to chipping on the medial edge. Greatest dorsoventral length of the ASLS5 is 27.4 mm, and its greatest mediolateral width is about 28.8 mm. There are no smooth centers and both sesamoid surfaces appear to have some small amount of porousness. Lateral sesamoid surface has a stained border showing where its sesamoid primarily set. Lastly, there are two more obvious depressions on the posterior side besides the central concavity. There is a concavity in the bone above the dorsal rims of the ASMS5 and ASLS5. There is also a contouring concavity beneath the posteriorly extended ASC3.

Phalanges

As is normal of proboscideans, *Mammot* has three types of phalanges: proximal, medial, and distal. Proximal phalanges articulate proximally with the distal ends of the metacarpals. Medial phalanges articulate proximally with the distal ends of the proximal phalanges. Distal phalanges articulate proximally with the distal ends of the medial phalanges. Morphology and number of phalanges is variable in proboscideans, whether by genera or by different individuals of the same species (Regnault et al. 2017). Digits II, III, and IV generally have all three phalanges but the phalangeal number varies typically with digits I and V (Ramsay and Henry 2001; Fowler 2006; Hutchinson et al. 2008, Siegal-Willott, Alexander, and Isaza 2012, Regnault et al. 2017). With ETMNH 305, there are five proximal phalanges, four medial phalanges, and five terminal or distal phalanges. Digit I lacks a medial phalanx. Even though only the distal phalanx for digit III is available, the distal ends on the medial phalanges for digits II through V, and the distal surface on the proximal phalanx for digit I, indicate that there were other distal

phalanges. Additionally, proximal phalanges are also prone to pathologies, whether from injuries or from the stress of weight loading.

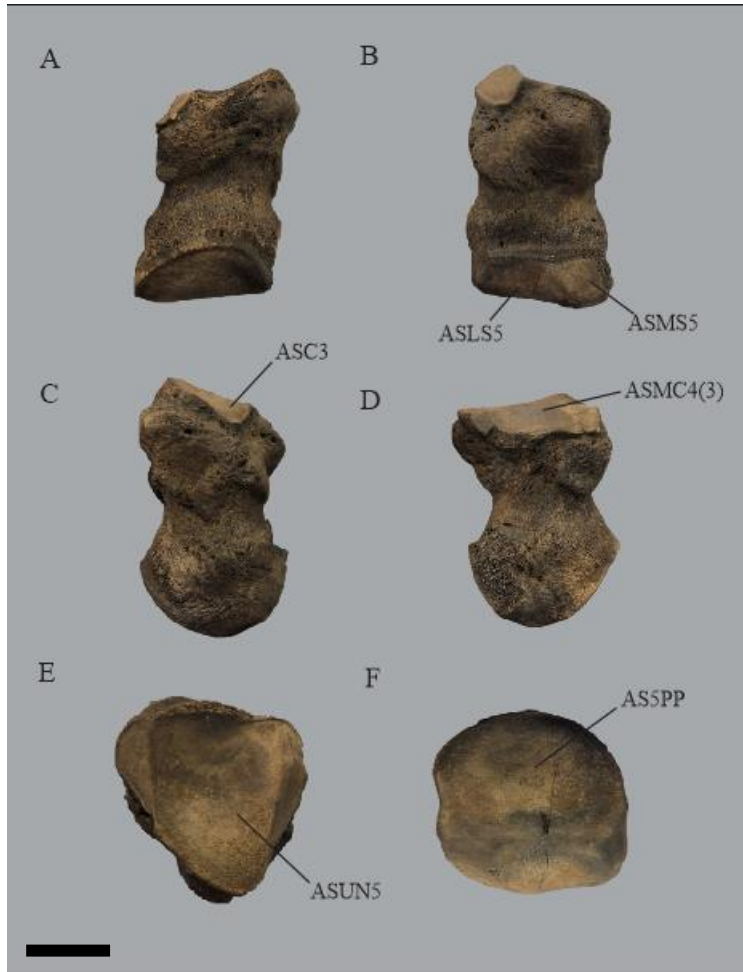


Figure 15: Left Metacarpal V of ETMNH 305

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASLS5, articular surface for the lateral sesamoid of digit V; ASMS5, articular surface for the medial sesamoid of digit V; ASC3, third articular surface for the cuneiform; ASMC4(3), third articular surface for metacarpal IV; ASUN5, fifth articular surface for the unciform; AS5PP, articular surface for the proximal phalanx of digit V. Scale bar = 5 cm.

Proximal Phalanges

Proximal Phalanx Digit I. The proximal phalanx for digit I (Figure 16) articulates proximally with the distal surface of Metacarpal I and distally with the proximal surface of the terminal phalanx for digit I. It is dorsoventrally elongate and mediolaterally and anteroposteriorly narrow. Its greatest dorsoventral length is 91 mm; its greatest mediolateral length is 70 mm; and its greatest anteroposterior width is 55 mm. Proximal phalanx for digit I, or PP1, is very complete with no missing pieces or cracking, but there are several surfaces with cortical surface chipping from weathering.

In dorsal view, the bone is entirely comprised of the articular surface that articulates with AS1PP. This articular surface (ASDMC1) is more oval shaped rather than circular and it has a rounded posterior and anterior apex. ASDMC1 is about 33 mm in mediolateral width and about 28.7 mm in anteroposterior length. There is a centromedial, darkened circle in the articular surface that is smooth and close to the posteromedial rim. The facet rim is raised above the articular surface except for the posteromedial edge, where it is flush with the surface and depresses towards the posterior side of the PP1. Besides the dark circle, most of the articular surface is rough with many small nodular projections and porous, especially along the edge. The lateral rim also has an upraised bony growth on its lateral maximally extended articular rim.

In medial view, there is a concave channel in the mediolateral center whereas both the anterior and posterior sides are also slightly concave. Anterior side exhibits the greater concavity of the two. Ventral outline is convex, and the dorsal outline is concave. The bone is rugose and has a lot of weathering. Regardless, some soft tissue fibrous interweaving is seen near both the dorsal and ventral margins, along with small foramina.

In ventral view, the distal articular surface that articulates with the proximal articular surface of the terminal phalanx for digit I (ASDPP1) is the main feature. This surface (ASTP1) does not extend into the anterior plane but terminates in the center of the ventral U-shape curvature where it is outlined by a dark, smooth, and sometimes shiny facet border. The distal articular surface is about 22.9 mm in mediolateral width and 13.5 mm in anteroposterior length. The ventral surface from the center to the anterior side is rugose. There is also significant weathering on its medial and anterior sides, but the rest of the articular surface is lighter and extends into the posterior plane. The surface is also smooth and has a central dip between the medial and lateral sides of the surface. The central dip also has two subtle tear drop shape divets. Lateral side of the surface projects more ventrally than its medial counterpart and also exhibits more outer surface bone erosion. Both the medial and lateral margins are posteriorly convex with a central cleft whereas the anterior side is concave.

In lateral view, the bone is very concave from the dorsal to ventral margin, significantly more so than its medial counterpart. Anterior and posterior curvatures are both concave, with the posterior exhibiting the greater inwards curvature. Dorsal margin is concave and the ventral outline is convex. The bone surface is entirely rugose but a hint of the posterolateral ASTP1 is seen in lateral view. Contouring this articular surface and the ventral outline is a dark, smooth band of bone. Otherwise, the bone has soft tissue attachment surfaces and small foramina, which are more concentrated proximally.

In anterior view, the medial and lateral sides are concave, although the medial outline is barely concave whereas the lateral outline is much greater. Dorsal outline is convex, with the posterior side of the ASDMC1 forming a dorsal apex. Ventral margin is also undulating, with a central dip and the medial condyle extends ventrally more than the lateral condyle. The bone is

very straight except for a small concave channel that runs in its mediolateral center beneath the rim of extended bone that is circling the entire proximal circumference of the phalanx, and above the U-shape of the ventral surface. A lot of erosion is present, especially on the distal end. Distally, there is a central depression between the medial and lateral condyles. Shiny fibers are paralleling the darkly colored dorsal facet rim shape and some small foramina are scattered here. In the central concavity there are two vertical rows of a set of 3 small foramina.

In posterior view, the outlines of the bone match with the description for the anterior view, although in this view, the ventral outline looks less undulating and more straightly diagonal from the lateral side down to the medial side with very little concavity in the center. The bone is mostly rugose with many soft tissue attachments visible and the ASTP1 is seen where it curves into the posterior side with a circular depressed cleft in the center. There are no sesamoid articular surfaces but there is a possible cartilaginous surface with an indeterminate width from chipping but with an approximate 5.6 mm dorsoventral length. A single large foramen is centrally located in the bone, almost directly above the cleft in the ASTP1. Medially of the foramen, two small osseous cyst-like lesions are visible.

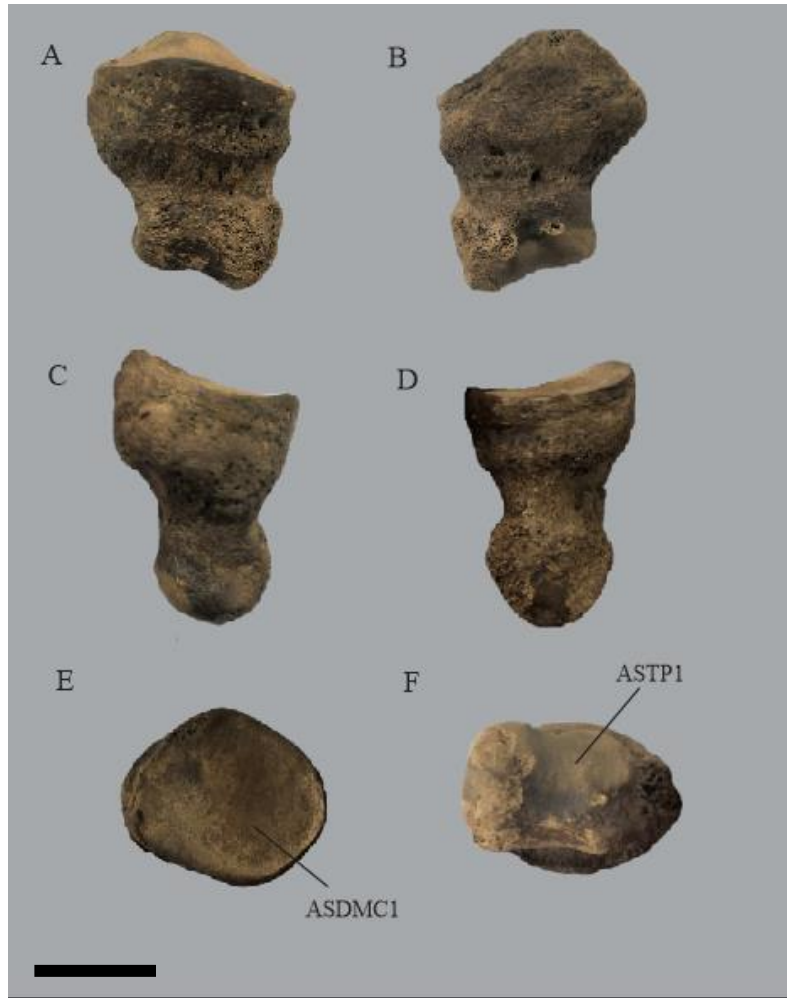


Figure 16: Left proximal phalanx of digit I of ETMNH 305. A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASTP1, articular surface for the terminal phalanx of digit I; ASDMC1, articular surface for the distal surface of metacarpal I. Scale bar = 5 cm.

Proximal Phalanx Digit II. The proximal phalanx for digit II (Figure 17) articulates proximally with the distal surface of Metacarpal II and distally with the proximal surface of the medial phalanx for digit II. It is dorsoventrally elongate and mediolaterally and anteroposteriorly narrow. Its greatest dorsoventral length is 111 mm; its greatest mediolateral width is 102 mm; and its greatest anteroposterior width is 71 mm. Proximal phalanx for digit II, or PP2, is very complete with some missing bone from heavy chipping and outer cortical weathering.

In dorsal view, the oval articular facet that articulates with the distal articular surface of the second metacarpal is the prominent feature (ASDMC2). ASDMC2 is about 42.2 mm in greatest mediolateral width and 34 mm in greatest anteroposterior length. Shape of the facet is more tear dropped, with the lateral side comprising the point, with rugose bone extending beyond the articular surface. The articulation itself is concave with the posterior side extending more proximally than the anterior section. Surface is somewhat smooth in the central area whereas the surrounding surface has a slightly porous texture, which increases in proximity to the rim. Most of the anterior facet rim is chipped off though the surface shape relative to the chipped terminations implies that the rim would have lipped up from the surface. Posterior rim is flush with the surface for the most part.

In medial view, the posterior, anterior, and dorsal outlines of the bone are all inwardly concave whereas the ventral outline is convexly U-shaped. Posterior curvature is also more pronounced than the anterior's. Medial side is quite straight compared to its greatly curved lateral counterpart, but there is a concave channel in the center between the same two rims of bone (extended proximal circumference and distal medial condyle) noted in the proximal phalanx for digit I. Dorsal section has the parallel fibers, with small foramina, following the

dorsal rim orientation, and the ventral section, with a few small and one large foramina, might have had some soft tissue webbing texture but erosion is present.

In ventral view, the oval articular surface that articulates with the proximal articular surface for the medial phalanx of digit II (ASPMP2) is the prominent feature and mimics the ASDMC2 facet in shape in that the lateral side is narrower than the medial. Ventral facet is about 35.7 mm in greatest mediolateral width and has a anteroposterior length of about 24.6 mm.

Majority of the central surface is smooth but some porous holes are quite apparent over the posterior rim into the posterior articular surface continuation and near the anterior facet border. There are two separate but parallel ridges on the articular surface towards the anterior border. These ridges contour the actual facet border and the space between the articular border and the first ridge is darker than the rest of the surface and has the anteriorly porous surface, which does extend to the second ridge too. The ridges are 9 and 18 mm from the real rim respectively. Most of the facet border is flush with the articular surface except for a small segment in the anterolateral corner.

In lateral view, the anterior and posterior outlines are concave, with the posterior side more inwardly curved. Dorsal outline is concave with the posterior edge making the higher edge and the ventral outline is convexly U-shaped. Lateral side is greatly curved with an undulating surface that is proximally extended and inwardly runs to the lateral U-shape condylar rim. The entire lateral section is rugose, comprised of fibrous intercrossed, parallel, and webby textures and no foramina are visible. Outer cortical erosion is apparent.

In anterior view, the rugose bone is mostly straight with a subtle concavity in the center. Some webbing or fibrousness might have been located dorsally or ventrally but erosion has made

that determination difficult. All outlined sides are concave. Some small foramina are scattered about, with more of them being dorsally located. The ventral facet barely extends into the anterior surface and is darkly rimmed.

In posterior view, the most noticeable features in the rugose bone is a pathology, but also the distal articular surface that curved into the posterior's ventral side. There are large osseous cyst-like lesions on the posterior side, various scattered from the medial to the lateral side. Cyst closest to the medial side is almost 23 mm dorsoventrally long and 8 mm mediolaterally wide. Laterally bordering it is a cyst about 18 mm dorsoventrally long and 12 mm mediolaterally wide. Both extend deep into the bone at 15.9 mm. In the dorsolateral corner, there is a cyst opening 23.5 mm mediolaterally wide and 14 mm dorsoventrally long that appears to be where two cysts fused together. A smaller cyst formed beneath this one.

Dorsal outline is more diagonal convex curve, with the medial side being more distal than the lateral. Fibers parallel the dorsal articular border's curvature. No foramina are visible on this posterior plane. Medial outline has a central concave channel, and the lateral outline is undulating from the dorsal rugose protrusion down to the ventral edge. Ventral outline is barely concave, almost straight, and the distal articular surface extends into the posterior side. Though greatly chipped away from erosion, some of its surface is still preserved, along with a darker and smoother cartilage surface which is located above the distal articular surface. Part of a cleft is seen between the medial and lateral sides of this surface. Mediolateral width of the cartilaginous surface is about 22.5 mm and its dorsoventral length is about 6.3 mm.

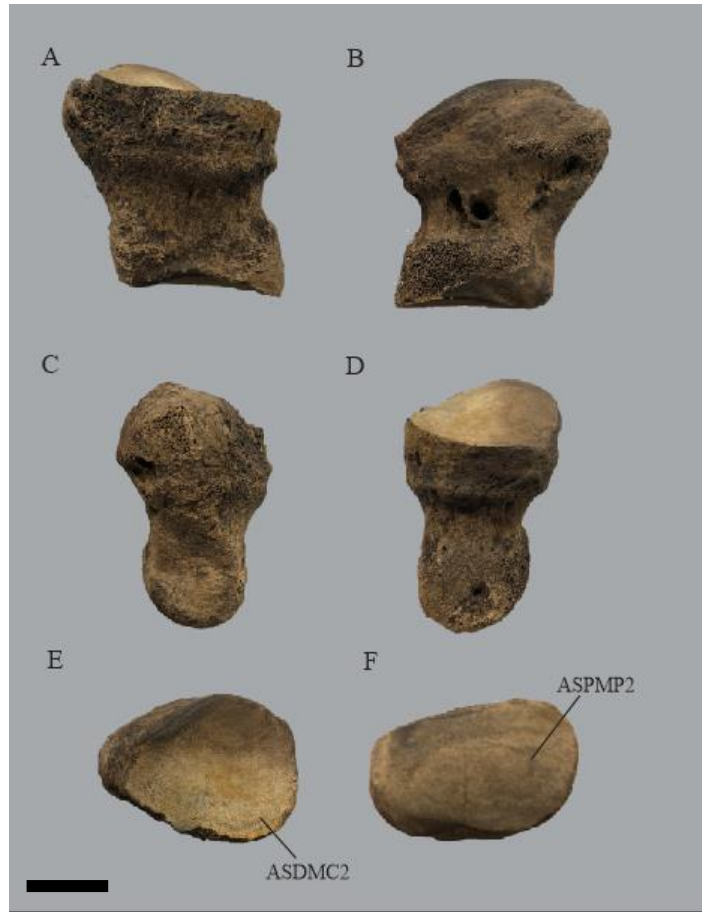


Figure 17: Left proximal phalanx of digit II of ETMNH 305. A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASPMP2, articular surface to the proximal surface of the medial phalanx of digit II; ASDMC2, articular surface to the distal surface of metacarpal II. Scale bar = 5 cm.

Proximal Phalanx Digit III. The proximal phalanx for digit III (Figure 18) articulates proximally with the distal surface of Metacarpal III and distally with the proximal surface of the medial phalanx for digit III. It is dorsoventrally elongate and mediolaterally and anteroposteriorly narrow. Its greatest dorsoventral length is 109 mm; its mediolateral width is 96 mm; and its greatest anteroposterior width is 72 mm. Mediolateral width is less than maximal by several millimeters due to the chipped of fragments on the lateral side. Proximal phalanx for digit III, or PP3, is very complete with some missing bone fragments from its lateral side and a crack running down its entire anterior face.

In dorsal view, the entire surface is comprised of the articular surface that articulates with the distal articular surface of the third metacarpal (ASDMC3). This slightly concave articular surface is about 41.5 mm in mediolateral width and 32.7 mm in greatest anteroposterior length. Mediolateral width is not at its maximum though due to the missing proximal lateral fragments. Overall shape is symmetrically oval, and the posterior side is flatter than the rest. The surface has a smooth and darkly stained circular center but is rough in texture and porous around the center, especially closer to the articular borders, which are generally raised above the surface itself. Near the anterolateral margin, the articular surface has a small, 1.5 mm osteolytic pathology that has smooth edges and delves into the bone's surface.

In medial view, the rugose bone and has no obvious foramina. Posterior curvature is deeply concave but the anterior outline is hardly concave, and mostly straight. Ventral outline has the typical U-shape convex curvature and the dorsal outline is similar to the anterior's in that its concavity is so subtle, the outline is almost flatly straight. Medial side itself has a central concave channel but the distal U-shaped bone extends outwards medially, and the proximal bone extends medially more so with a rugose protrusion or nodule of bone. Distal extension has more

fibrous soft tissue attachments and the proximal nodule would probably be similar but cortical weathering has removed these features.

In ventral view, the articular surface that articulates with the proximal articular surface on the medial phalanx for the digit III is the prominent feature (ASPMP3). This surface is an oblong, symmetrical oval and is darkly rimmed. It is about 23.1 mm in mediolateral width and is 38.6 mm in anteroposterior length. Most of the surface is smooth, especially the dark rimming, and any pores visible are close to the smooth border. Center of the surface has a anteroposterior swath that is also dark, though not as dark as the rimming. The dark center is wider near the posterior margin, where the distal articular surface curves into the bone's posterior side.

In lateral view, the rugose bone symmetrically mirrors the bone's medial side, which is apparent even with the missing fragments that are proximally and posteroventrally located on the lateral side. The outlines, proximal and distal extensions, central channel, and soft tissue attachments are all similar; however, the central channel does have some small foramina visible on the lateral side. Other foramina might have been on this side but cortical weathering along with the missing fragments has removed any possible foramina in the areas other than the channel.

In anterior view, the PP3 is very rugose and symmetrical. Both the medial and lateral outlines display a central channel running between proximal and distal extensions in the bone. These medial proximal and distal extensions project medially outwards to roughly the same extent. Likely, the lateral side would have mirrored the medial side in this case. Dorsal outline is convex and the ventral outline is subtly concave, almost straight. Anterior side itself is almost straight with only a small concave curvature. There is a ridge of bone running around the proximal circumference, in line with the proximal extensions on the medial side. Also, the

ventromedial corner has a rugose nodular bone that triangular is pointing towards the anterior's center. This nodule is lacking on the ventrolateral corner and not because of any missing fragments. ASPMP3 curves into the anterior side with an upwardly convex curvature. This darkly rimmed surface has a depression proximal to the border, paralleling its shape. Various small foramina are visible, especially near the dorsomedial corner.

In posterior view, the two most notable features are the cartilaginous surface and the cyst features. Ventrally, there is an upwardly convex surface that is dark and smooth. The surface does not appear to be an articular one, but rather a cartilaginous one with a 32.9 mm mediolateral width and a 9.1 mm dorsoventral height. There is a round cleft in its center and some of its lateral surface is missing due to chipping, meaning the width measurement is a few mm less than maximal. Medial and lateral cartilaginous segments are equal in size, and there are no sesamoid articular surfaces. Posterior side is deeply convex, rugose, and has a proximal circumference ridge of bone protruding from the rest of the bone with some fibrous webbing and soft tissue interweaving attachment fibers visible. Below the proximal ridge and above the cartilaginous surface, the center of the bone's concavity, there are 5 osseous cysts like lesions. PP3 has the most possible pathological features. The first lesion is located close to the lateral side and is 13.0 mm in mediolateral width and is 8.6 mm in dorsoventral length. The second lesion, dorsocentrally located, is 12 mm in mediolateral width and 15.7 mm in dorsoventral length. This lesion extends into the bone's interior by about 6.5 mm. A lesion below the dorsocentral one is 10.9 mm mediolaterally wide and is 25.3 mm dorsoventrally long. This cysts lesion extends into the bone 9.2 mm. The fourth lesions is medial to the third and is 5.9 mm in mediolateral width and 4.2 mm in dorsoventral length. The last lesion, even more medially located, is 15.4 mm in

mediolateral width and 15.5 mm in dorsoventral length. If depth was not mentioned, the lesional depth was not as extreme and was just a few mm in.



Figure 18: Left proximal phalanx of digit III of ETMNH 305. A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASPMP3, articular surface to the proximal surface of the medial phalanx of digit III; ASDMC3, articular surface to the distal surface of metacarpal III. Scale bar = 5 cm.

Proximal Phalanx Digit IV. The proximal phalanx for digit IV (Figure 19) articulates proximally with the distal surface of Metacarpal IV and distally with the proximal surface of the medial phalanx for digit IV. It is dorsoventrally and mediolaterally elongate and anteroposteriorly narrow. Its greatest dorsoventral length is 103.5 mm; its greatest mediolateral width is 105 mm; and its greatest anteroposterior width is 77 mm. Proximal phalanx for digit IV, or PP4, is largely complete with only a crack running through the entire bone with some small missing fragments lost because of the splitting.

In dorsal view, the articular surface that articulates with the distal articular surface on the metacarpal IV (ASDMC4) takes up the entire dorsal view. ASDMC4 is circular and has an anteroposterior length of about 35.2 mm and mediolateral width of about 44.7 mm. The surface is mostly smooth, with no major dark staining or porousness; however, there is an apparent line running from the anteromedial corner to the posterolateral corner where the more anterolateral surface is upraised from the rest of the articular surface. Elevated surface is light in color whereas the rest is a darker brown and more porous, though the lighter section does have a porous rim. Articular border is also raised above the articular surface around the entire facet except for the anteromedial and posterolateral edges, which are flush with the surface. Beyond the articular rim at the posterolateral edge, there is a posterolateral projection of rugose bone.

In medial view, the bone is rugose and has some cortical weathering. Posterior outline is greatly concave whereas the anterior outline is only slightly so, being more straight than curved. Dorsal outline is also flatly straight, and the ventral outline is convexly U-shaped. Proximal area has a subtle mediolateral ridge for soft tissue attachment, along with some small foramina. Below the ridge, is a small depression but the bone's medial side is mostly straight or flat. There

is an osseous cyst-like lesion in medial view, near the posterior concave apex approximately 4 mm mediolaterally wide and 6 mm dorsoventrally in length.

In ventral view, the articular surface that articulates with the proximal articular surface of the medial phalanx for digit IV (ASPMP4) is very oblong, oval, and smooth. Its greatest mediolateral width is 22.1 mm and its maximal anteroposterior length is 37.4 mm. The surface has a dark band of smooth articular surface following the anterior rim outline. Near the surface's center, there is also the beginnings of an osteolytic pathology, only a mm or two in size, that indents into the bone's surface but does not delve into it. It has smooth edges like the others that have been mentioned. Overall, the surface is not that porous and stays smooth throughout, but the main central surface is raised from the surface that extends into the anterior view and from the cartilaginous surface that extends from the ASPMP4 into the posterior view.

In lateral view, the rugose bone is like its medially sided counterpart, except for the lack of lesions. Outlines are the same and soft tissue attachments are seen mostly in the distal U-shape since the proximal end has some cortical weathering. Small foramina are seen along the dorsal rim and there is also a proximal ridge that starts at the posterodorsal end and extends down and inward towards the bone's center. This rugose ridge is much more pronounced than the one on the medial side. There are also small foramina along the dorsal margin.

In anterior view, the PP4 is very square. Rugose bone has the proximal circumference ridge, which does not connect with the medial and lateral proximal ridges. Medial outline is moderately straight with a little central indentation, which would be the same for the lateral side if it wasn't for its pronounced proximal and posterior ridge, which laterally extends the dorsolateral corner. Dorsal outline is moderately flat as is the ventral margin; however, the medial corner of the ventral outline is slightly more distally extended than the lateral side. Part of the ASPMP4

curves up into the anterior view and is convexly curved and darkly colored. Above the articular rim, the anterior side's rugose bone depressed from the border.

In posterior view, the rugose PP4 has a very pronounced proximal circumference ridge, which does connect with the proximal ridge on the medial and lateral sides. The ridge has several soft tissue attachment fibers making webbing patterns and parallel threading. The bone is deeply concave below the ridge, with many lesion features present. The first pathology is located near the dorsolateral corner and below the proximal ridge. It is 6.9 mm in mediolateral width and 14.4 mm in dorsoventral length. The second lesion is medial to the first and is 19.9 mm in mediolateral width and 15.5 mm in dorsoventral length. These two lesional cyst pockets are more shallow than the two distal ones. The third pathology is more central, close to the cartilaginous surface, and is about 9.3 mm in mediolateral width, and roughly 22.5 mm in dorsoventral length. This pocket recedes into the bones interior by about 14.5 mm, making it the deepest cyst pocket. The inner cyst surface is also smooth, with twisted looking bone surfaces. The last lesion is directly central and bordering the cartilaginous surface and is 7.0 mm in mediolateral width, 6.7 mm in dorsoventral length, and is 9.2 mm deep. Below the possible pathological features is the cartilaginous surface, which is smooth, dark, and separated into medial and lateral sections by a small proximal cleft. Overall, this surface is about 30 mm mediolaterally wide and about 11.4 mm in dorsoventral height. Width is off by a several mm due to surface chipping on the medial side.

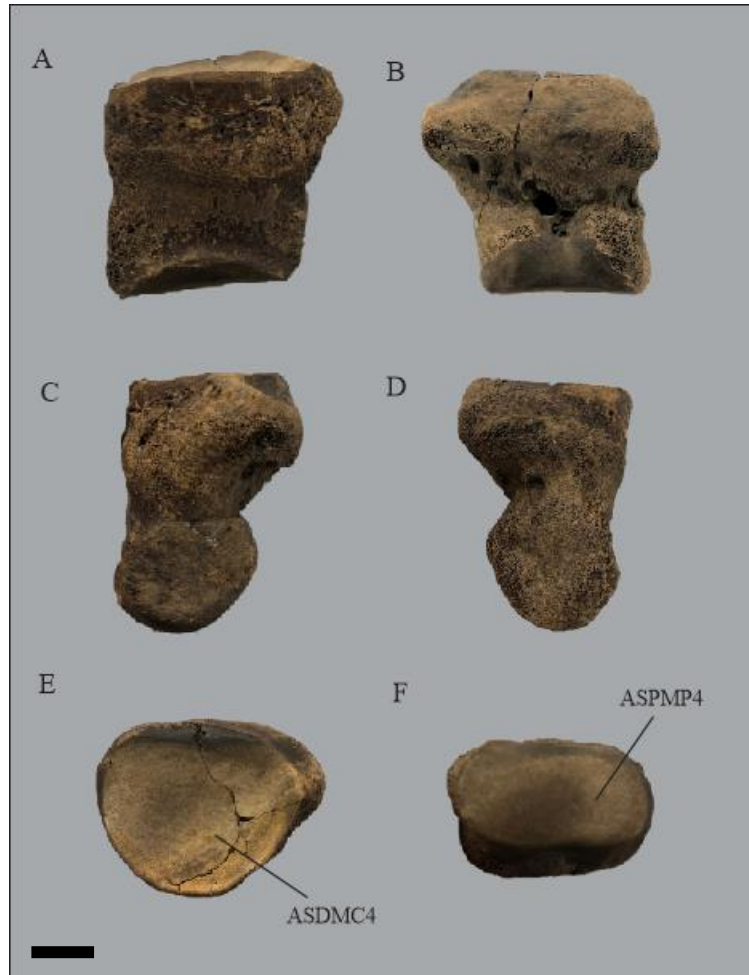


Figure 19: Left proximal phalanx of digit IV of ETMNH 305. A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASPMP4, articular surface to the proximal surface of the medial phalanx of digit IV; ASDMC4, articular surface to the distal surface of metacarpal IV. Scale bar = 5 cm.

Proximal Phalanx Digit V. The proximal phalanx for digit V (Figure 20) articulates proximally with the distal surface of Metacarpal V and distally with the proximal surface of the medial phalanx for digit V. It is dorsoventrally elongate and mediolaterally and anteroposteriorly narrow. Its greatest dorsoventral length is 116 mm; its mediolateral width is 85 mm; and its anteroposterior width is 69 mm. Dorsoventral length is accurate but the mediolateral and anteroposterior widths are in error due to the missing fragments, making them less than maximal, but close to it. Proximal phalanx for digit V, or PP5, is mostly complete but is missing several small to large fragments on every surface, making it the least complete proximal phalanx.

In dorsal view, the circular articular surface that articulates with the distal articular surface of metacarpal V (ASDMC5) is greatly fragmented in the anterior and anterolateral areas. Mediolateral width of the ASDMC5 is about 77 mm and its anteroposterior length was measured at about 62.9 mm where there are two preserved sides. Anteroposterior length is several mm from maximal length due to the missing surfaces. Preserved surfaces are light in color with a smooth, unstained center, and are rimmed by porous bone. Articular border is raised above the surface except for the posterolateral corner where the surface is flush with the border. A posterolateral rugose protrusion extends beyond the flushed facet rim.

In medial view, the ASDMC5 is visible with the posterior margin making its highest point as in concavely curves down to the broken anterior margin. ASDMC5 is downwardly slanted towards the medial side, which is why it is visible in this view. Both the anterior and posterior sides appear to be flat beneath a proximal rugose ridge that seems to sinuate the bone's circumference. On the medial side, this rugose ridge has small foramina and soft tissue attachment fibers and there is a small concave channel beneath it. This concave channel is more understated than in any other proximal phalanx. Within the channel, there are either two large

foramina or two large osseous cyst-like lesion pockets; however, outer surface weathering makes it hard to distinguish between the two.

In ventral view, the articular surface that articulates with the proximal articular surface on the medial phalanx for digit V (ASPMP5) is pear shaped, with the lateral end being the narrower surface area. It has a greatest mediolateral width of 69.5 mm and a greatest anteroposterior length of 48.8 mm. The overall surface is smooth with a slightly darker center and porous rims. Articular rims seem upraised from the surface except for the lateral side where it is flush with the surface and is thicker than the rest of the border. A small circular indent, about half a mm across, might also be the start of an osteolytic pathology in the center of the articular surface.

In lateral view, the anterior and posterior outlines are concave, with the posterior side having the greater inwards curvature. Dorsal outline is partially missing but appears to be moderately flat, and the ventral outline is convexly U-shaped. Although there is a large missing fragment near the proximal end, there is still an apparent and large, laterally extending rugose protrusion that curves into the center of the bone's lateral side. This protrusion has some soft tissue fibrous attachments but much of those features are missing. Also, the proximal anterior area is missing, and no visible foramina are present.

In anterior view, the PP5 is very proximally busted. ASDMC5 is visible, with the more posterior surface curvature being elevated. Dorsal outline is convex whereas the medial and ventral outlines are slightly concave. Lateral outline is mostly convex with the large rugose protrusion on the lateral side creating a significant lateral bulge, but this curvature does cut inwards near a small distal segment. ASPMP5 does not curve into the anterior plane like the distal articular surfaces of the other proximal phalanges did. There is some cortical weathering

on this anterior surface, but some soft tissue attachments and some small foramina are visible near the unbroken distal end. Anteromedial corner is more distal than the lateral side too.

In posterior view, the dorsal outline is convex, and the ventral outline is concave, but both have more distally extended medial sides. Medial and lateral outlines are slightly concave. Center of the posterior side is deeply concave with a few lesion pockets within. The first osseous cyst-like lesion is laterally oriented and is 8.9 mm in dorsoventral length and 7.2 mm in mediolateral width. The second cyst pocket is centrally located and is 4.8 mm in dorsoventral length and 4.4 mm in mediolateral width. The third lesion is 11.0 mm in dorsoventral length and 6.6 mm in mediolateral width. These pockets are moderately shallow, especially compared to the lesions on the PP3 and PP4. Beneath the possible pathological features is the cartilaginous surface, which is heavily chipped away, although the chipping looks like it followed the outline of the surface. If this is the case, the cartilaginous surface could be about 64.7 mm in mediolateral width and about 30 mm in dorsoventral height. A central cleft was probably also present as it is in the other proximal phalanges, but this area is missing bone so is indeterminate.

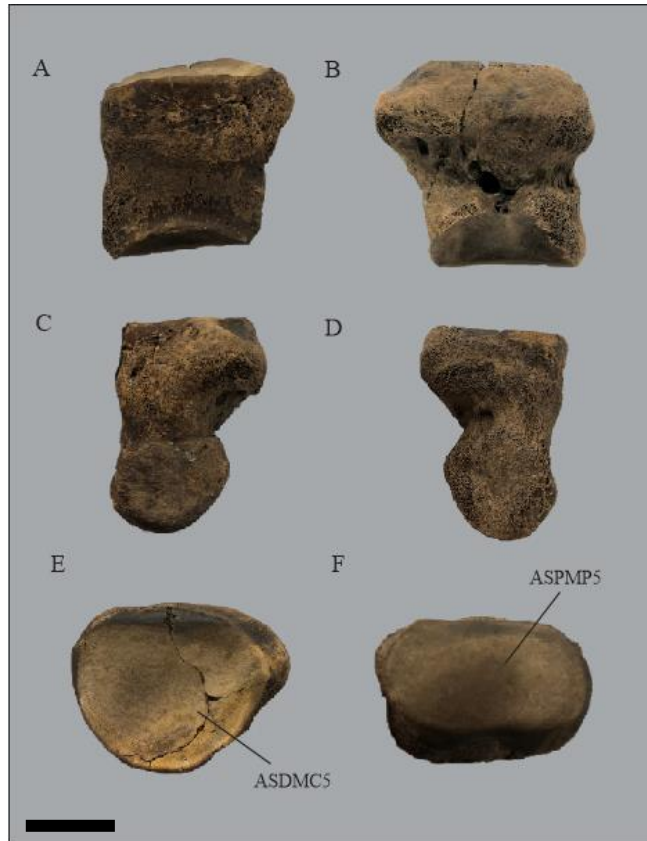


Figure 20: Left proximal phalanx of digit V of ETMNH 305. A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASPMP5, articular surface to the proximal surface of the medial phalanx of digit V; ASDMC5, articular surface to the distal surface of metacarpal V. Scale bar = 5 cm.

Medial Phalanges

Medial Phalanx Digit II. The medial phalanx for digit II (Figure 21) articulates proximally with the distal surface of PP2 and distally with the proximal surface of the terminal phalanx for digit II. It is mediolaterally elongate and dorsoventrally and anteroposteriorly narrow. Its greatest dorsoventral length is 64.0 mm; its mediolateral width is 75.5 mm; and its anteroposterior width is 47.0 mm. Medial phalanx for digit II, or MP2, is complete, with just cortical bone weathering.

In dorsal view, the articular surface that articulates with the distal articular surface of the proximal phalanx for digit II (ASDPP2) is the main feature. ASDPP2 is very oval shaped and deeply concave, with the posterior side more elevated than the anterior. It is about 34.7 mm in mediolateral width and 20.6 mm in anteroposterior length. The surface is not smooth but porous with many small nodules. Articular border is raised above the articular surface and there is not any inner rimming or ridges; however, there is a darker circle that is posterolaterally oriented within the articular surfaces. The surface is not much smoother than the rest.

In medial view, the bone is entirely rugose. Dorsal outline is flat and diagonal, going from the posterior side down to the anterior. Anterior and posterior outlines are slight concave, almost equally. Ventral outline is convexly rounded, but not quite U-shaped. There is a rugose ridge that runs from the proximal posterior margin across and down to the anterior distal margin. There is a single medium sized foramen along the dorsal outline in the center.

In ventral view, the articular surface that articulates with the posterior articular surface for the terminal phalanx of digit II (ASTP2) is two-podded peanut shaped. Mediolateral width of the ASTP2 is about 25.9 mm. Anteroposterior length was taken at the central dip between the

medial and lateral sides of the ASTP2 and is about 11.7 mm. Center of the ASTP2 is concave, darkly stained, and is more porous than the rest of the surface. The whole ASTP2 is very smooth with little porousness and the articular border stays flush with the surface all the way around.

In lateral view, the rugose bone strongly mirrors its medial sided counterpart. Dorsal outline is concave, along with the posterior outline, and the ventral outline is still roundly convex. Anterior outline appears convex, and this is caused by the proximal protruding ridge that extends from the proximal posterior corner across and down into the center of the anterior margin. A medium sized foramen is in the center of the protruding ridge.

In anterior view, the dorsal outline is shaped by the elevated posterior margin to the ASDPP2, which is convex. Ventral margin concave, as is the medial outline. Lateral outline is convex, with the greater curvature expressed proximally. The entire surface is rugose, with many small foramina located beneath the dorsal rim, and there is a dark convexly rugose surface near the distal end. This surface could be where cartilage was probably present and above it, there is a mediolaterally elongated and depressed trench or pit.

In posterior view, the dorsal outline is convex; the ventral outline is concave, the medial outline is concave; and the lateral outline is subtly convex. More prominent feature in this view is the dark cartilaginous surface that is distally located. This surface is convexly curved towards the proximal end of the MP2 and is very smooth with a subtle indented cleft in the center. Its approximate mediolateral width is about 25.8 mm and its dorsoventral height is about 8.9 mm. Above the cartilaginous surface, the bone is concave and rugose with many small foramina and soft tissue attachment fibers. Dark coloring of the cartilaginous surface also continues towards the proximal end and a small oval of lighter bone is in its center. Rugosity lessens towards the dorsal margin, where it becomes smoother and foramina are absent.

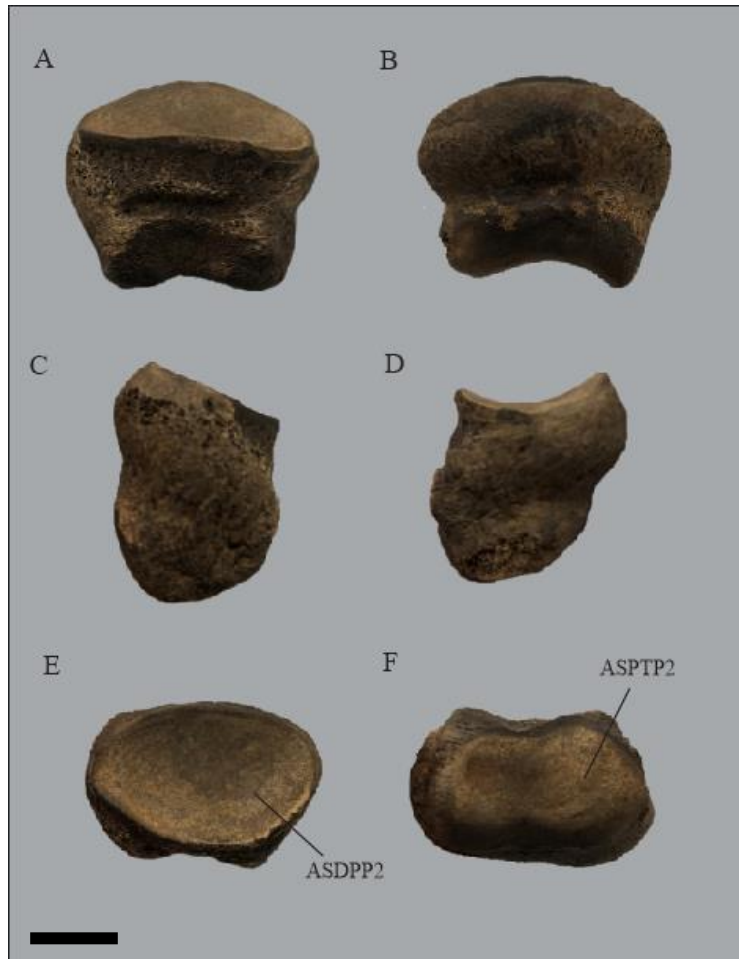


Figure 21: Left medial phalanx of digit II of ETMNH 305. A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASPTP2, articular surface to the posterior surface of the terminal phalanx of digit II; ASDPP2, articular surface to the distal surface of the proximal phalanx of digit II. Scale bar = 5 cm.

Medial Phalanx Digit III. The symmetrical medial phalanx for digit III (Figure 22) articulates proximally with the distal surface of PP3 and distally with the proximal surface of the terminal phalanx for digit III. It is mediolaterally elongate and dorsoventrally and anteroposteriorly narrow. Its greatest dorsoventral length is 66.0 mm; its mediolateral width is 77.0 mm; and its anteroposterior width is 47.0 mm. Medial phalanx for digit III, or MP3, is complete, with just cortical bone weathering and some minor chipping.

In dorsal view, the articular surface that articulates with the distal articular surface of the proximal phalanx for digit III (ASDPP3) is the main feature. ASDPP3 is very oval shaped and deeply concave, with the posterior side more elevated than the anterior. It is about 34.7 mm in mediolateral width and 21.3 mm in anteroposterior length. Posterocentral surface is smooth and darker than the surrounding articular surface, which is elevated after a ridge separates the darker surfaces from the lighter. The lighter surface is more porous. Articular border is elevated above the articular surface except for the posteromedial corner where it is flush with it. In the center of the ASDPP3, which is antero-centrally within the darker circle, there are several small osteolytic features, about a half millimeter each.

In medial view, the bone is entirely rugose. Dorsal and posterior outlines are concave whereas the anterior and outline is convex. Ventral outline is convexly rounded, but not quite U-shaped. There is a rugose ridge that runs from the proximal posterior margin across and down to the anterior central margin, which gives the anterior side is convex outline. There is a single small foramen along the dorsal margin in the center and other small foramina are scattered throughout along with soft tissue attachments.

In ventral view, the articular surface that articulates with the posterior articular surface for the terminal phalanx of digit III (ASTP3) is oval. Mediolateral width of the ASTP3 is about

23.3 mm. Anteroposterior length was taken at the slight central dip between the medial and lateral sides of the ASTP3 and is about 13.5 mm. Center of the ASTP3 raised in two different circular spots that anteroposteriorly oriented, darkly stained, and is more porous than the rest of the surface. There is also a raised ridge that parallels the rimming contour near the anteromedial margin, which is dark and smooth. The whole ASTP3 is very rough with porousness, except for the anterior side, which is smooth. Articular border stays flush with the surface at the lateral and medial margins but is otherwise elevated above the ASTP3.

In lateral view, the rugose bone mirrors its medial sided counterpart. Dorsal outline is concave, along with the posterior outline, and the ventral outline is still roundly convex. Anterior outline appears convex, and this is caused by the proximal protruding ridge that extends from the proximal posterior corner across and down into the center of the anterior margin. Small foramina are visible along the proximal anterior margin.

In anterior view, the MP3 is very symmetrical. Dorsal outline is shaped by the elevated posterior margin to the ASDPP3, which is convex. Ventral margin is strongly concave. Lateral and medial outlines are convex, with the greater curvature expressed proximally. The entire surface is rugose, with many small foramina located beneath the dorsal rim, and there is a dark convexly rugose surface near the distal end. This surface could be where cartilage was probably present and above it, there is a mediolaterally elongated and depressed trench or pit. There are a few small foramina in the elongated pit.

In posterior view, the dorsal outline is convex; the ventral outline is greatly concave; and the medial and lateral sides are subtly concave. Greatest point of depression lines up with the maximal proximal extension of the cartilaginous surface, which is the most prominent feature in this view. Dark cartilaginous surface is distally located and spans the entire mediolateral width.

This surface is convexly curved towards the proximal end of the MP3 and is very smooth with a subtle indented cleft in the center. Its approximate mediolateral width is about 26.2 mm and its dorsoventral height is about 4.4 mm. Above the cartilaginous surface, the bone is concave and rugose, and the dark coloring of the cartilaginous surface also branches up and around a lighter circle of bone. The circle of bone is in the very center of the posterior side. Rugosity lessens towards the dorsal margin, where it becomes smoother and foramina are absent. Foramina are mostly apparent near the medial and lateral sides.

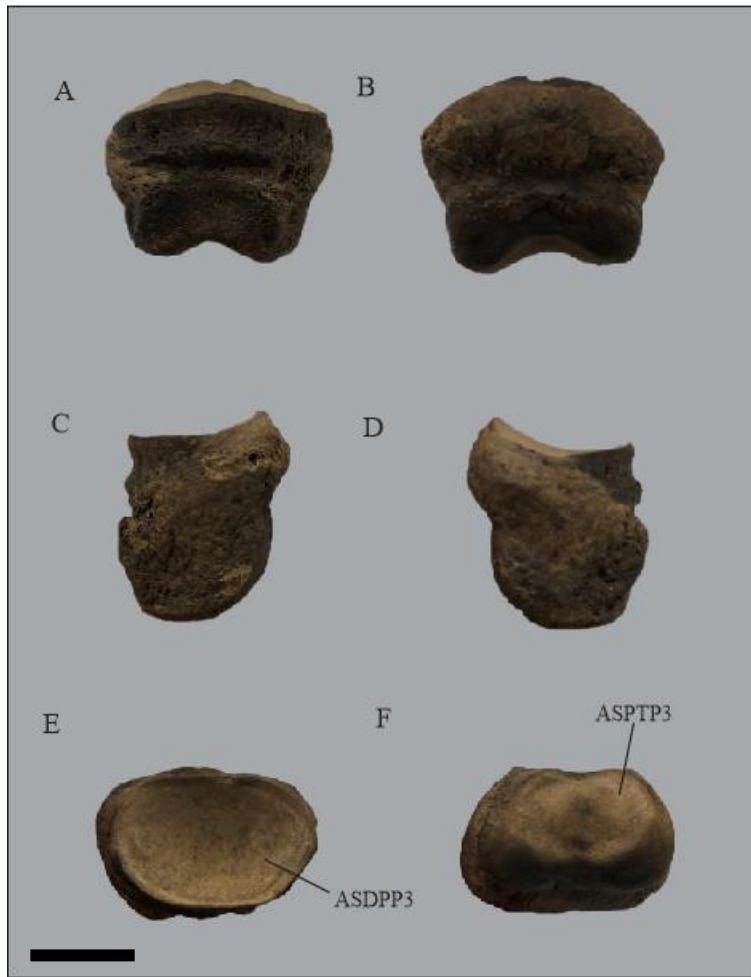


Figure 22: Left medial phalanx of digit III of ETMNH 305. A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASPTP3, articular surface to the posterior surface of the terminal phalanx of digit III; ASDPP3, articular surface to the distal surface of the proximal phalanx of digit III. Scale bar = 5 cm.

Medial Phalanx Digit IV. The medial phalanx for digit IV (Figure 23) articulates proximally with the distal surface of PP4 and distally with the proximal surface of the terminal phalanx for digit IV. It is mediolaterally elongate and dorsoventrally and anteroposteriorly narrow. Its dorsoventral length is 58.0 mm; its mediolateral width is 60.5 mm; and its greatest anteroposterior width is 45.0 mm. Mediolateral width is in error by several millimeters due to missing fragments on the lateral side, and the dorsoventral length might be less than maximal by a millimeter or two due to chipping along the proximal articular surface's rim. Medial phalanx for digit IV, or MP4, is mostly complete, with some missing fragments and surface weathering.

In dorsal view, the articular surface that articulates with the distal articular surface of the proximal phalanx for digit IV (ASDPP4) is the main feature. ASDPP4 is more circular shaped than oval and is deeply concave, with the posterior side more elevated than the anterior. It is about 55.0 mm in mediolateral width and 43.0 mm in anteroposterior length. Width is less than maximal by several millimeters due to the missing lateral margin. Center of ASDPP4 has a raised circle, which is lighter in color than the surround articular surface and is smooth except for 8 small one to two millimeter sized osteolytic features. Most are circular with smooth edges but two are tear drop shaped. Tear drop shaped features have the main hole with a line branching from it, and all the surrounding edges are smooth. Splitting lines diverging from the holes are directed towards the anterior margin. The depressed channel between the raised center and the surrounded raised articular borders is very rough and porous, and the depression is greatest anteriorly, decreasing posteriorly.

In medial view, the bone is entirely rugose. Dorsal and posterior outlines are concave, and the anterior outline is broken, though it looks like it might have been convex like the other medial phalanges. Ventral outline is convexly squarely rounded. There is a vague rugose ridge

that runs from the proximal posterior margin across and down to the anterior central margin, which could have given the anterior side a convex outline. Small foramina are along the proximal rim.

In ventral view, the articular surface that articulates with the posterior articular surface for the terminal phalanx of digit IV (ASTP4) is oval. Mediolateral width of the ASTP4 is about 46.5 mm. Greatest anteroposterior length is 27.7 mm. The oval narrows towards the medial end, and anteromedially, there is a darkly stained rim that parallels the articular border contour. The surface is darker and smoother in the center but rimmed by porous, lighter articular surface. All of the articular border stays flush with the ASTP4.

In lateral view, the rugose bone has many missing pieces. Much of the anterior, dorsal, and proximal ridge sections are missing; however, like the other proximal phalanges, this side probably mirrored its medial sided counterpart. Dorsal outline is concave, along with the posterior outline, and the ventral outline is still squarely convex rounded. Since part of a proximal protruding rugose ridge is visible, its likely it cut from the proximal posterior corner across and down to the center of the anterior margin, giving the anterior outline a convex curvature. Soft tissue fibrous attachments are not visible but small foramina are along the distal margin and one foramen is in the proximal ridge.

In anterior view, there is a missing segment stretching from the proximal lateral corner down to the center of the distal margin. Dorsal outline is shaped by the elevated posterior margin to the ASDPP4, which is convex. Ventral margin is concave. Medial outline is slightly concave but almost straight and the lateral outline is very convex, especially proximally. Lateral outline extends outwards significantly whereas the medial side does not. The entire surface is rugose, with many small foramina located beneath the dorsal rim. Dorsal foramina are in pairs, sitting

medially and laterally to one another. There is a dark convexly rugose surface near the distal end, which could be where cartilage was present, and above it, there is a mediolaterally elongated and depressed trench or pit. This pit is larger than those seen in the other medial phalanges and it has large foramina lining it. Towards to medial side, the foramina are in pairs and sit proximally and distally to each other. Towards the center, the foramina become large and single. This foramina pit is also much more proximally located than the others, which were more centrally located.

In posterior view, the dorsal outline is diagonal, extending from the lateral side and down to the medial; the ventral outline is concave with its greatest depression more laterally located; the medial side is concave; and the lateral side is convex. A small section of cartilaginous surface is distally located and spans the entire mediolateral width. This surface is convexly curved towards the proximal end of the MP4 with its apex being more laterally located. It is very smooth with no apparent central cleft. Its approximate mediolateral width is about 46.0 mm and its dorsoventral height is about 21.6 mm. Above the cartilaginous surface, the bone is concave and rugose. Rugosity lessens towards the dorsal margin, where it becomes smoother and foramina are absent. Foramina are mostly apparent near the medial and lateral sides.

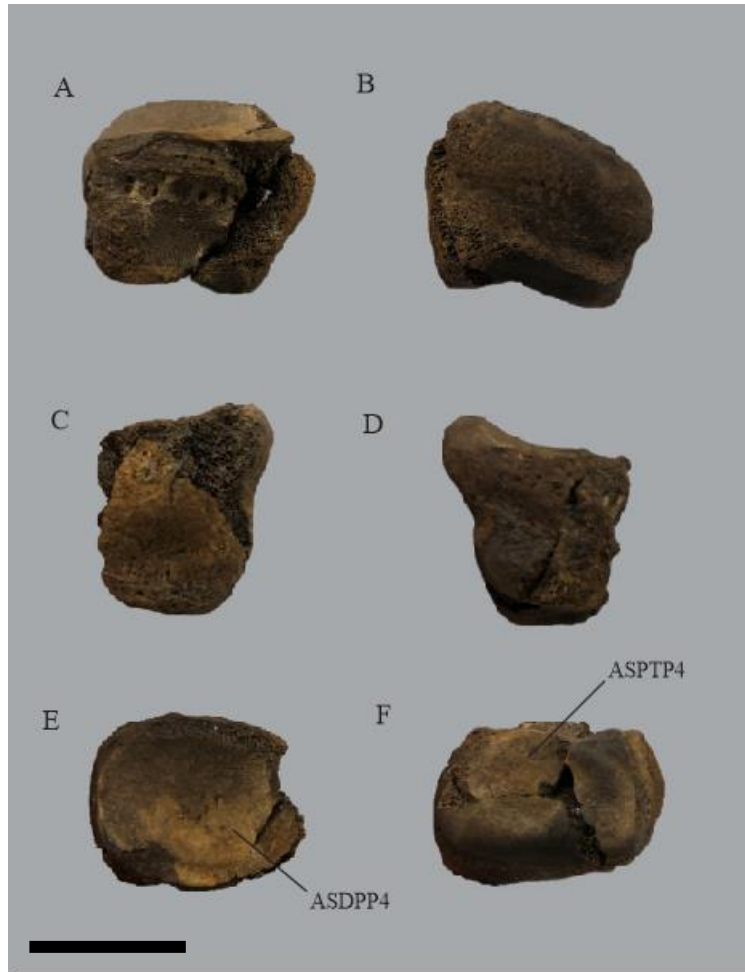


Figure 23: Left medial phalanx of digit IV of ETMNH 305. A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASPTP4, articular surface to the posterior surface of the terminal phalanx of digit IV; ASDPP4, articular surface to the distal surface of the proximal phalanx of digit IV. Scale bar = 5 cm.

Medial Phalanx Digit V. The medial phalanx for digit V (Figure 24) articulates proximally with the distal surface of PP5 and distally with the proximal surface of the terminal phalanx for digit V. It is dorsoventrally elongate and mediolaterally and anteroposteriorly narrow. Its dorsoventral length is 61.0 mm; its mediolateral width is 57.0 mm; and its greatest anteroposterior width is 44.0 mm. Medial phalanx for digit V, or MP5, is entirely complete, with very little surface weathering.

In dorsal view, the articular surface that articulates with the distal articular surface of the proximal phalanx for digit V (ASDPP5) is the main feature. ASDPP5 is very circular and is concave, with the posterior side more elevated than the anterior. It is about 55.3 mm in mediolateral width and 42.2 mm in anteroposterior length. Both measurements represent the maximums. Articular surface is very smooth with little porousness. There is an indented line paralleling the articular border contour from the medial side and posteriorly around the lateral side. The only dark surface is the oval shaped section that is posteriorly centered. This surface is not smoother or more porous than the rest, however. Articular border is entirely raised above the rest of the surface.

In medial view, the bone is entirely rugose. Dorsal outline is flatly diagonal from the posterior margin down to the anterior margin, and the anterior outline is subtly convex whereas the posterior margin is subtly concave. No ridges or protrusions are present. Very few foramina are seen scattered throughout and the soft tissue attachments fibers are vague, instead of greatly pronounced like they are in MP2 or MP3.

In ventral view, the articular surface that articulates with the posterior articular surface for the terminal phalanx of digit V (ASTP5) is bow shaped, with almost separate medial and lateral condyles. Greatest mediolateral width of the ASTP5 is about 36.3 mm, and the

greatest anteroposterior length is 25.4 mm. A deep cleft nearly separates the surface into medial and lateral sides, and this cleft is almost perfectly centered. ASTP5 is very smooth and dark in its center and its articular borders remain flush with it.

In lateral view, the dorsal outline is concave and tilts down towards the lateral side. Posterior and anterior outlines are concave, and the ventral outline is roundly convex. Medial side is wider than the lateral and it extends more distally; because of this, the medial side is visible framing the smaller lateral side. Lateral side is rugose, with some small foramina scattered about and some soft tissue attachment fibers are visible. There are no protrusions, ridges, or nodules.

In anterior view, the dorsal outline is shaped by the elevated posterior margin to the ASDPP5, which is convex. Ventral margin is deeply concave with the greatest depression more laterally located. Medial and lateral outlines are convex, with the medial side more convex in the center and the lateral side more convex proximally. The entire surface is rugose, with many small foramina located beneath the dorsal rim. There is a dark convexly rugose surface near the distal end, potentially for cartilage, and above it there is a small mediolaterally elongated and depressed trench or pit. This pit is smaller than those seen in the other medial phalanges and it has three medium sized foramina lining it.

In posterior view, overall shape of the MP5 matches its description of its anterior side. Dorsal outline is convex; ventral outline is concave with its greatest depression more laterally located; medial and lateral sides are convex. A small section of cartilaginous surface is distally located and spans the entire mediolateral width. This surface is convexly curved towards the proximal end of the MP5 with its apex being more laterally located. It is very smooth with an apparent central cleft. Above the cartilaginous surface, the bone is concave and rugose. Rugosity

lessens towards the dorsal margin, where it becomes smoother and foramina are absent.

Foramina are mostly apparent near the medial and lateral sides. Laterally, there is a small nodule near the center for soft tissue attachment, and towards the medial side, there is either a single large foramen or an osseous cyst-like lesion.

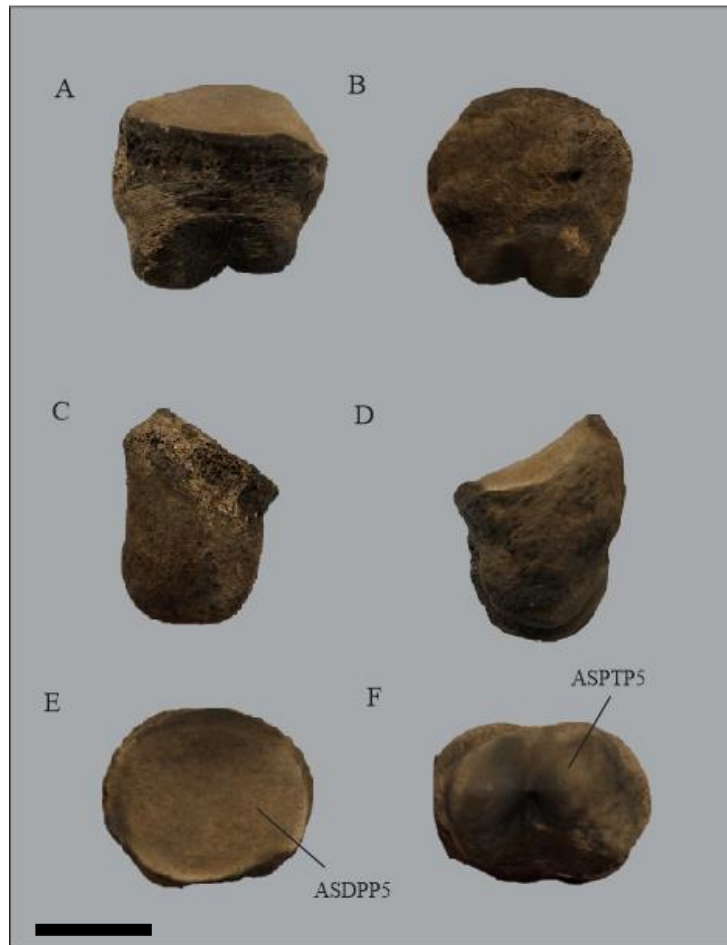


Figure 24: Left medial phalanx of digit V of ETMNH 305. A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASPTP5, articular surface to the posterior surface of the terminal phalanx of digit V; ASDPP5, articular surface of the distal surface of the proximal phalanx of digit V. Scale bar = 5 cm.

Terminal Phalanges

Terminal Phalanx Digit III. The terminal, or distal, phalanx for digit III (TP3) (Figure 25) articulates posteriorly with the distal articular surface of the medial phalanx for digit III. This terminal phalanx is a tripartite phalanx meaning it has bilateral wing lucencies (Regnault et al. 2017). It is mediolaterally elongate and dorsoventrally and anteroposteriorly narrow. Its mediolateral width is 42.0 mm; its greatest anteroposterior length is 27.5 mm; and its greatest dorsoventral length is 25.0 mm. Mediolateral width is not maximal since the medial and lateral projections are broken. Other than the broken bilateral wings, TP3 is complete.

In dorsal view, TP3 is a rounded and stubby triangle with an attached cylindrical anterior tuberosity and medially and laterally curving side projections. Point of the triangle is directed posteriorly and the rounded cylinder protrudes from the anterior base. The forward pointing projection has a rounded tip and a ring of bone extending outwardly from its circumference. On the medial and lateral sides, the beginnings of ossified projections curve out and back towards the posterior. These bilateral wing lucencies are thin and fragile. On the main triangular portion of TP3 the surface is rugose, and foramina encircle the base of the anterior tuberosity.

In medial view, the posterior outline is concave, which is the articular surface that articulates with the distal articular surface of the medial phalanx for digit III. Dorsal and ventral margins are convex and curve towards the anterior tuberosity. This tuberosity creates the anterior rounded point that subtly points ventrally. Basically, the main body of TP3 looks like a rounded disk with a triangular point stuck in its anterior side's center. Medial wing in this view is indeterminate since most of it is broken off and missing. Also, there seems to be a bony, arthritic looking growth on the dorsal side of the anterior projection. Body of TP3 has many small foramina scattered across its rugose body.

In ventral view, the actual ventral side of the bone is moderately flat. Its dorsal outline is convex and its anterior outline is sharply bell-shaped, with the anterior projection forming the bell top and the anterior bone making the bell base. Lateral wing is a long, thin, and posteriorly curved bone branching off the main body. Many foramina are visible in the view, and some even rim and convex curvature of bone that is anterior oriented just before the projection extends outwards.

In lateral view, the shape of TP3 mirrors what was described for its medial side, except that there is a tube-like wing curving posteriorly from the central body; however, this view displays more of the arthritic looking bony growth that extends from the dorsal rim of the main bone and extends to the top of the anterior point. A large foramen is in the lateral side of this extra growth, which stops just past the circumference ring of bone surrounding the anterior point. Not as many foramina are seen on the central body in this view as in the other.

In anterior view, the dorsal outline is convex whereas the ventral outline is almost flat with the slightly convexity. Medial projection is broken off and the lateral project extends outwards. Anterior tip is directly located in the center of the anterior face and comes to an acutely rounded point. Surface of the central body is rugose, with many foramina and some soft tissue attachment fibers apparent. This rugose surface is shiny from the medial side and up to the dorsal apex. From this view, the extra bony growth at the base of the anterior projection is dorsolaterally located.

In posterior view, the main feature is the articular surface that articulates with the distal articular surface of the medial phalanx for digit III. This articular surface (ASDMP3) is very circular and rough, with numerous small rugose nodules on its surface. Its darker in the center but not smoother. Articular rims are raised above the surface itself, with the medial and lateral

borders almost flush with the surface. Other than the articular surface, the bilateral wings are apparent.

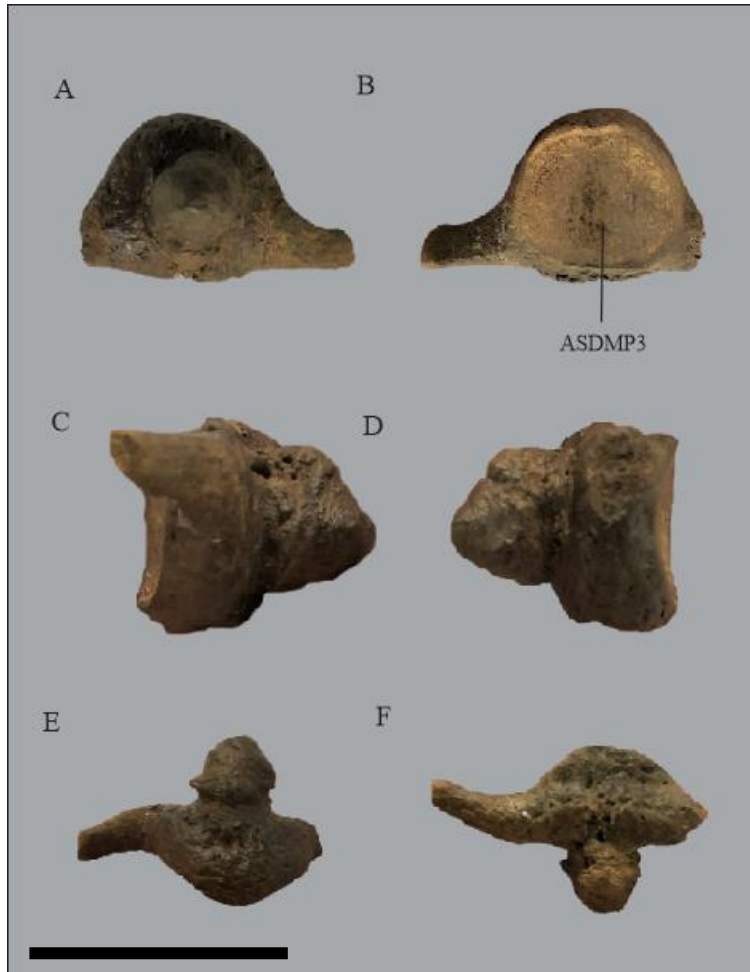


Figure 25: Left terminal phalanx of digit III of ETMNH 305. A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASDMP3, articular surface to the distal surface of the medial phalanx of digit III. Scale bar = 5 cm.

Sesamoids

Sesamoids are small round and tear drop shaped bones that articular with the distal medial and lateral articular surface on metacarpals and are always in pairs.

Metacarpal I Sesamoids. Associated with MC1, the medial and lateral sesamoids have fused together (Figure 26), forming a single, long wedge-shaped bone that is mediolaterally elongate and dorsoventrally and anteroposteriorly narrow. Its greatest mediolateral width is 56.5 mm; its greatest dorsoventral length is 31.0 mm; and its greatest anteroposterior width is 27.4 mm. The bone is complete and has little weathering. Posterior side of the bone is a single convexly curved, rugose surface, but the anterior side that articulates with the distal posterior side of the MC1 still has two distinct medial and lateral articular surfaces with a cleft between them. Lateral articular surface (LSMC1) is the smaller one with a 17.5 mm mediolateral width and a 22.6 mm dorsoventral height. The cleft forms depression between the LSMC1 and the medial articular surface (MSMC1). MSMC1 has a mediolateral width of 30.2 mm and and dorsoventral height of 22.4 mm. Both articular surfaces have a raised central surface that is roughly 2.5 mm to 3.0 mm from the articular border, which is smoother than the porous surrounding surface.

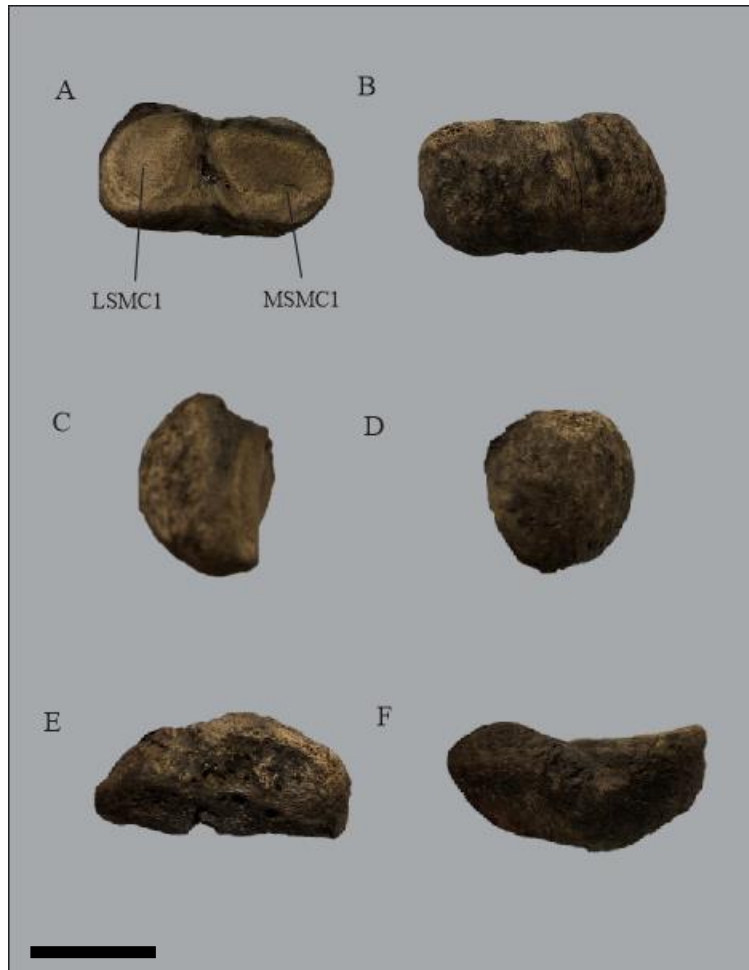


Figure 26: Left Metacarpal I fused sesamoids of ETMNH 305. A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. LSMC1, articular surface of the lateral sesamoid to metacarpal I; MSMC1, articular surface of the medial sesamoid to metacarpal I. Scale bar = 5 cm.

Metacarpal II Sesamoids. The paired sesamoids for MC2 are separate. Lateral sesamoid (Figure 27) is tear shaped, and the point is directed proximally. It is dorsoventrally elongate and mediolaterally and anteroposteriorly narrow. Its greatest dorsoventral length is 64.0 mm; its greatest mediolateral width is 44.0 mm; and its greatest anteroposterior width is 44.0 mm. Lateral sesamoid is complete but exhibits surface weathering. The bone is rugose except for its anterior and medial facets. Anterior articular surface that articulates with the distal end of MC2 is 40.0 mm in mediolateral width and 52.7 mm in dorsoventral length. This surface (ALSMC2) is oval and porous. Articular surface on the medial side of the lateral sesamoid (MLSMC2) articulates with the medial side of the paired medial sesamoid. MLSMC2 is chipped and is 20.5 mm in dorsoventral length and 8.3 mm in anteroposterior width. Dorsoventral length could have been about 38 mm. Lateral side of the lateral sesamoid has three foramina, two of which are large, in its center. Lateral sesamoid has a depressed ring of bone running around near the anterior articular surface, which could be where the tendons attached.

The medial sesamoid (Figure 28) is tear shaped, and the point is directed proximally. It is dorsoventrally elongate and mediolaterally and anteroposteriorly narrow. Its greatest dorsoventral length is 68.0 mm; its greatest mediolateral width is 43.0 mm; and its greatest anteroposterior width is 44.0 mm. Medial sesamoid is complete but exhibits surface weathering. The bone is rugose except for its anterior and medial facets. Anterior articular surface that articulates with the distal end of MC2 is 33.6 mm in mediolateral width and 58.4 mm in dorsoventral length. This surface (AMSMC2) is oval and smooth with little porousness along the borders, and it narrows proximally. There is an osteolytic pathology near the center of the AMSMC2, with smooth edges. Articular surface on the medial side of the medial sesamoid (MMSMC2) articulates with the medial side of the paired lateral sesamoid. MMSMC2 is chipped

and is 30.0 mm in dorsoventral length and 7.8 mm in anteroposterior width. Dorsoventral length could have been about 45 mm. On the lateral side, there are either two large foramina in the center of the bone, or there are two osseous cyst-like lesional pockets. All sides of the bone have a concave channel-like depression for the tendons to sinuate.

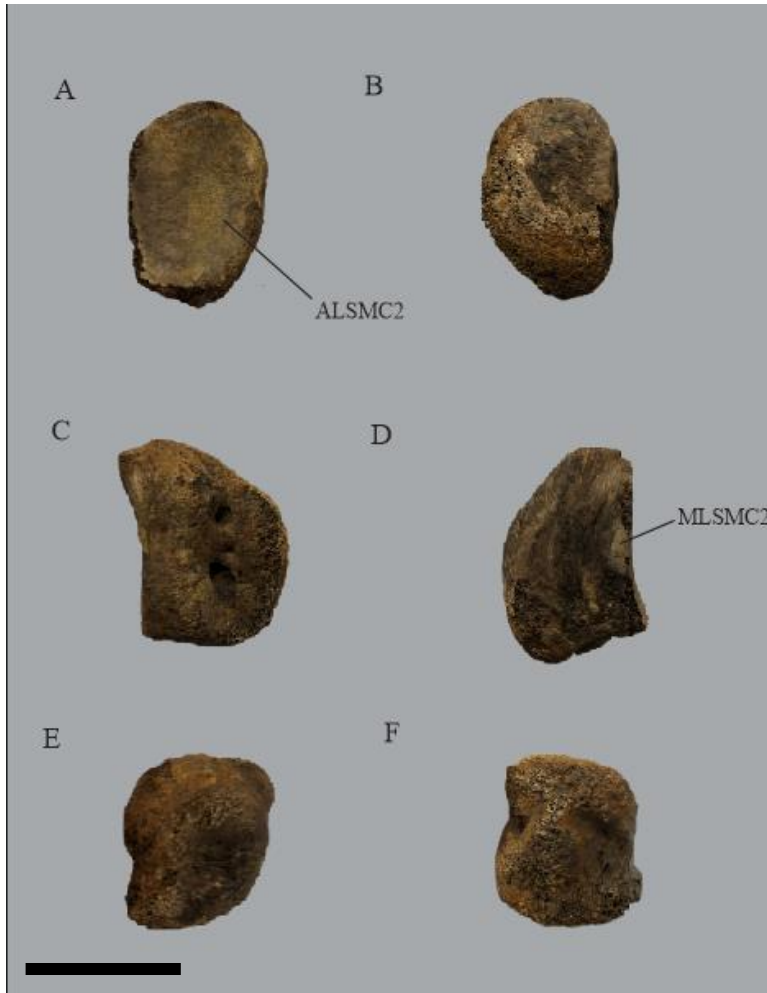


Figure 27: Left Metacarpal II lateral sesamoid of ETMNH 305. A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ALSMC2, anterior articular surface of the lateral sesamoid to metacarpal II; MLSMC2, medial articular surface to the lateral sesamoid to metacarpal II. Scale bar = 5 cm.

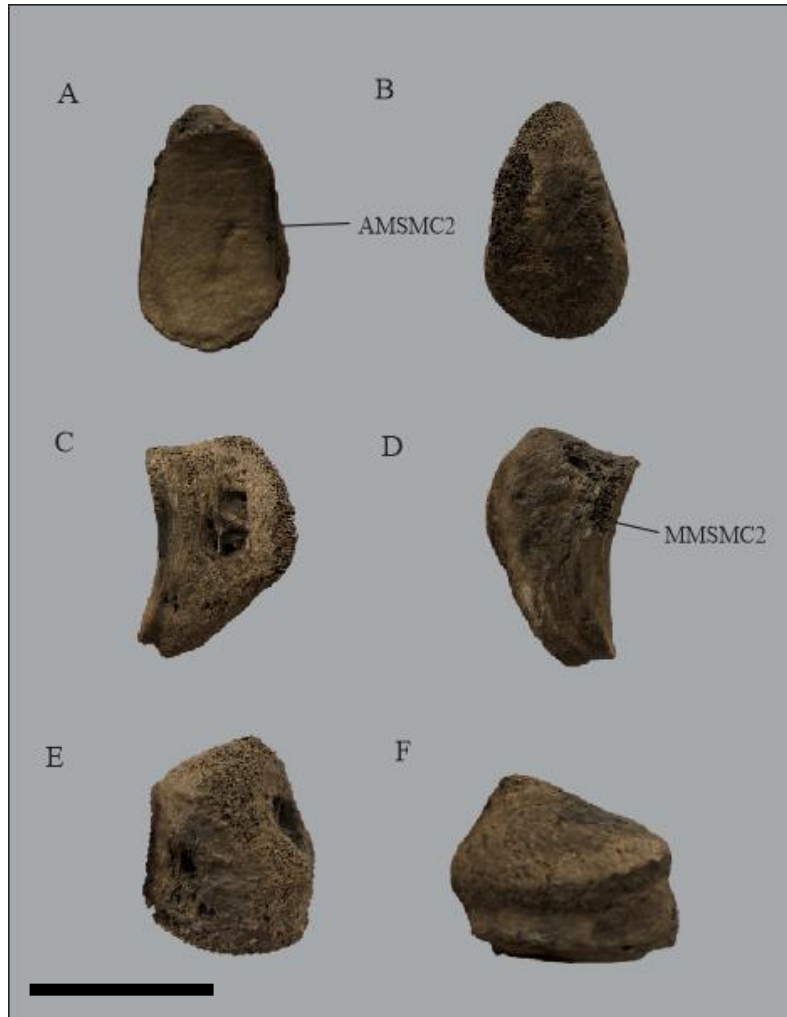


Figure 28: Left Metacarpal II medial sesamoid of ETMNH 305. A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. AMSMC2, anterior articular surface to the medial sesamoid of metacarpal II; MMSMC2, medial articular surface to the medial sesamoid of metacarpal II. Scale bar = 5 cm.

Metacarpal III Sesamoids. The paired sesamoids for MC3 are separate or unfused. Lateral sesamoid (Figure 29) is tear shaped, and the point is directed proximally. It is dorsoventrally elongate and mediolaterally and anteroposteriorly narrow. Its dorsoventral length is 61.0 mm; its greatest mediolateral width is 37.5 mm; and its greatest anteroposterior width is 42.0 mm. Dorsoventral length is less than maximal due to a missing proximal section. Lateral sesamoid is mostly complete but exhibits surface weathering and has a broken proximal posterior section. The bone is rugose except for its anterior and medial facets. Anterior articular surface that articulates with the distal end of MC3 is 35.3 mm in greatest mediolateral width and 51.4 mm in dorsoventral length. This surface (ALSMC3) is oval, porous, and narrows proximally. Articular surface on the medial side of the lateral sesamoid (MLSMC3) articulates with the medial side of the paired medial sesamoid. MLSMC3 is 29.9 mm in dorsoventral length and 6.7 mm in anteroposterior width. Lateral side of the lateral sesamoid has small foramina scattered about. All sides of the bone have a depressed center for the tendons to sinuate.

The medial sesamoid (Figure 30) is tear shaped, and the point is directed proximally. It is dorsoventrally elongate and mediolaterally and anteroposteriorly narrow. Its greatest dorsoventral length is 63.0 mm; its greatest mediolateral width is 46.5 mm; and its greatest anteroposterior width is 42.0 mm. Medial sesamoid is complete but exhibits surface weathering. The bone is rugose except for its anterior and medial facets. Anterior articular surface that articulates with the distal end of MC3 is 39.4 mm in mediolateral width and 51.3 mm in dorsoventral length. This surface (AMSMC3) more circular than oval and smooth with little porousness along the borders. There is a small dimpling near the proximal border, which might be the start of an osteolytic pathology. Articular surface on the medial side of the medial sesamoid (MMSMC3) articulates with the medial side of the paired lateral sesamoid. MMSMC3 is 26.6

mm in dorsoventral length and 6.3 mm in anteroposterior width. On the lateral side, there 5 foramina, three of which are large. These foramina are clustered in the center of the lateral side. This medial sesamoid has the same tendon concavity encircling the bone as the other sesamoids.

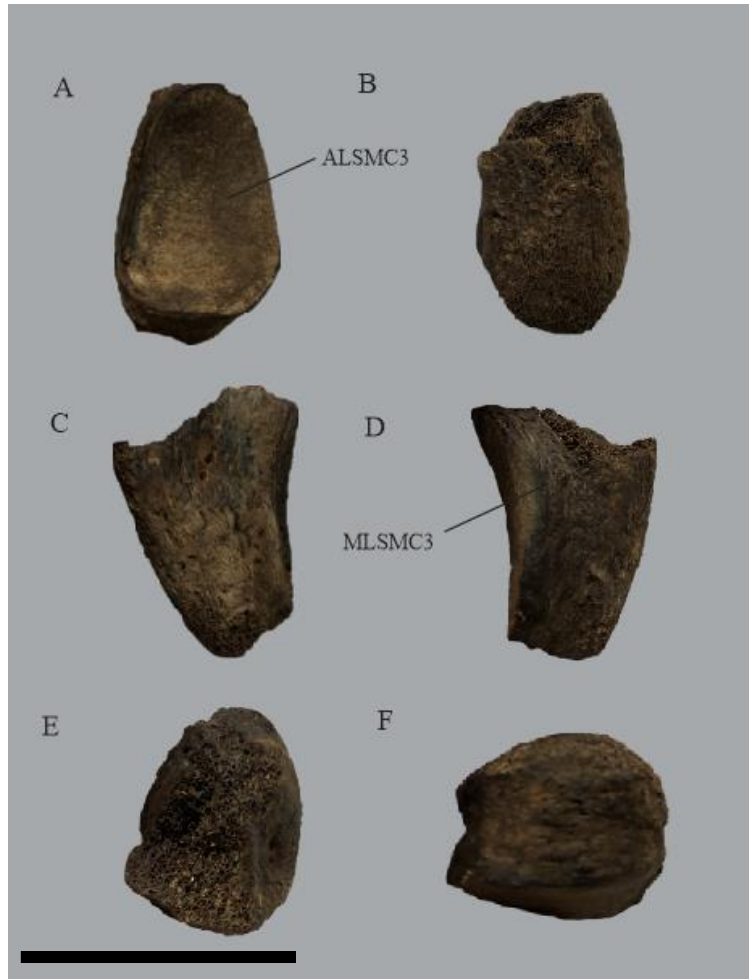


Figure 29: Left Metacarpal III lateral sesamoid of ETMNH 305. A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ALSMC3, anterior articular surface of the lateral sesamoid to metacarpal III; MLSMC3, medial articular surface to the lateral sesamoid to metacarpal III. Scale bar = 5 cm.

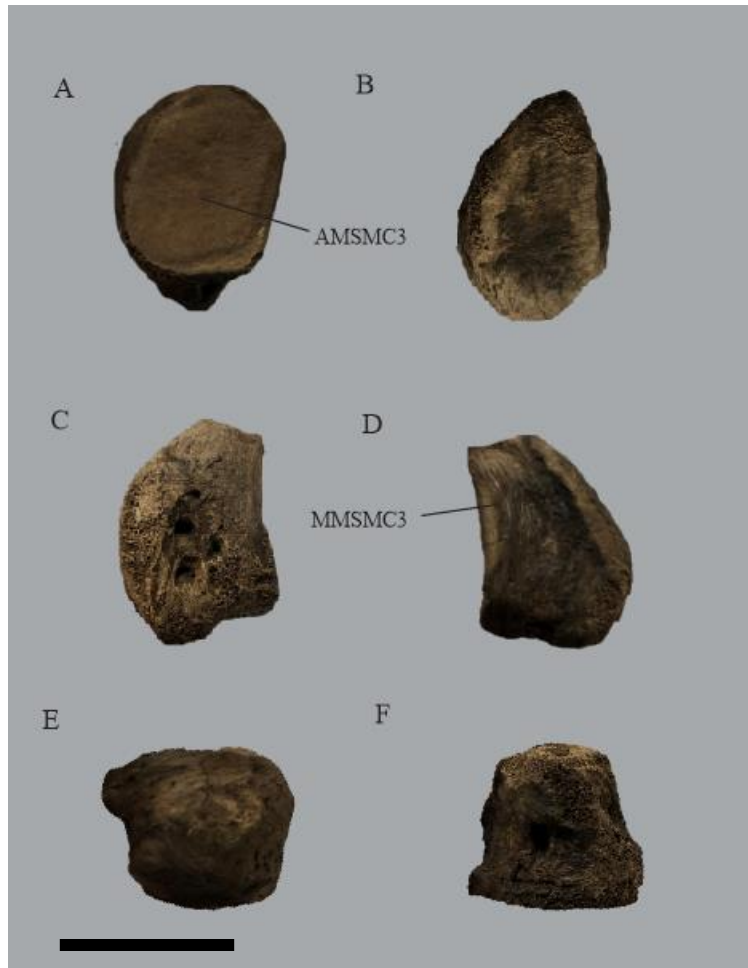


Figure 30: Left Metacarpal III medial sesamoid of ETMNH 305. A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. AMSMC3, anterior articular surface to the medial sesamoid of metacarpal III; MMSMC3, medial articular surface to the medial sesamoid of metacarpal III. Scale bar = 5 cm.

Metacarpal IV Sesamoid. The paired sesamoids for MC4 are separate or unfused (Figure 31). Lateral sesamoid is tear shaped, and the point is directed proximally. It is dorsoventrally elongate and mediolaterally and anteroposteriorly narrow. Its dorsoventral length is 64.0 mm; its greatest mediolateral width is 47.0 mm; and its greatest anteroposterior width is 40.0 mm. Lateral sesamoid is complete but exhibits surface weathering. The bone is rugose except for its anterior and medial facets. Anterior articular surface that articulates with the distal end of MC4 is 39.0 mm in greatest mediolateral width and 53.9 mm in dorsoventral length. This surface (ALSMC4) is oval, porous but with a smoother center, and narrows proximally. Articular surface on the medial side of the lateral sesamoid (MLSMC4) articulates with the medial side of the paired medial sesamoid. MLSMC4's dorsoventral length and anteroposterior width are indeterminate due to severe chipping of the articular surface. Lateral side of the lateral sesamoid has 1 medium foramen that is close to the posterior margin. All sides of the bone have a depressed center for the tendons to sinuate. Medial sesamoid for the MC4 is missing.

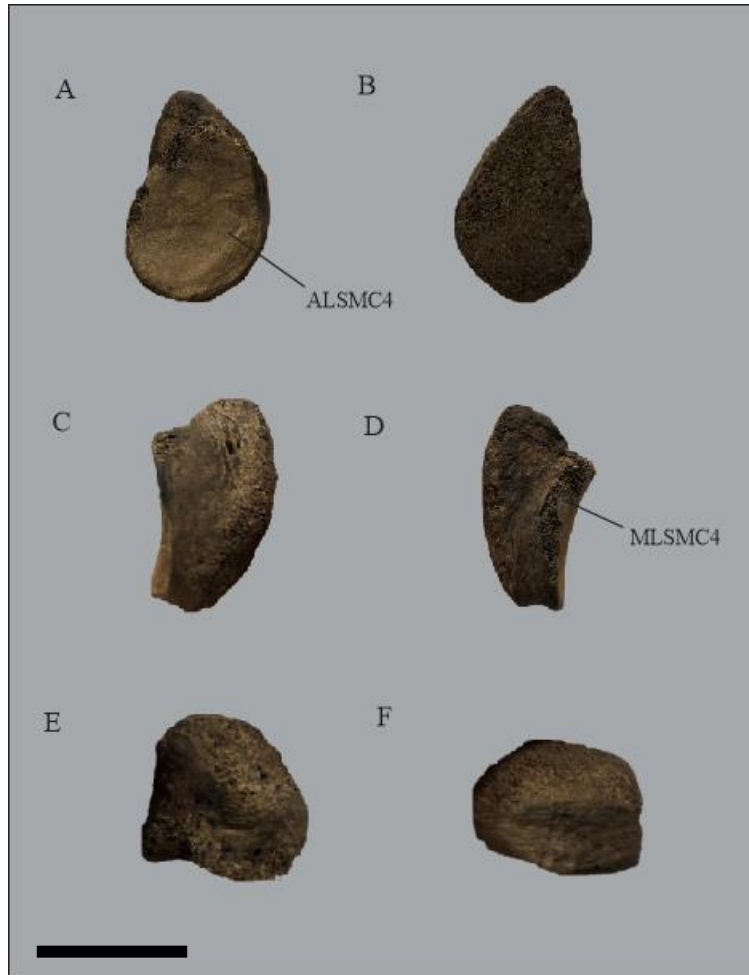


Figure 31: Left Metacarpal IV lateral sesamoid of ETMNH 305. A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ALSMC4, anterior articular surface of the lateral sesamoid to metacarpal IV; MLSMC4, medial articular surface to the lateral sesamoid to metacarpal IV. Scale bar = 5 cm.

Metacarpal V Sesamoids. The paired sesamoids for MC5 are separate or unfused. Lateral sesamoid (Figure 32) is circular, with an underlying point that is directed proximally. It is dorsoventrally elongate and mediolaterally and anteroposteriorly narrow. Its dorsoventral length is 57.5 mm; its greatest mediolateral width is 51.0 mm; and its greatest anteroposterior width is 43.5 mm. Lateral sesamoid is complete but exhibits surface weathering. The bone is rugose except for its anterior and pseudomedial facets. Anterior articular surface that articulates with the distal end of MC5 is 46.8 mm in greatest mediolateral width and 48.4 mm in dorsoventral length. This surface (ALSMC5) is circular and porous with a raised articular surface ring that is about 4.5 mm wide that encircles the rest of the concave articular surface. Raised articular ring is not porous but smooth near the proximal margin. There is also a small osteolytic pathology in the center of the facet, inside a slightly darker stained surface area. Articular surface on the medial side of the lateral sesamoid (MLSMC5) articulates with the medial side of the paired medial sesamoid. MLSMC5 is a pseudo articular surface because it is actually just a portion of the ALSMC5 that curved down into the medial side of the bone and is not a separate facet. It is 30 mm in dorsoventral length and 5.5 mm in anteroposterior width. Lateral side of the lateral sesamoid has one large foramen centrally located near the posterior margin. All sides of the bone have a depressed center for the tendons to sinuate, which are also darkly colored and sometimes have a shine.

The medial sesamoid (Figure 33) is tear shaped, and the point is directed proximally. It is dorsoventrally elongate and mediolaterally and anteroposteriorly narrow. Its greatest dorsoventral length is 54.0 mm; its greatest mediolateral width is 40.0 mm; and its greatest anteroposterior width is 39.0 mm. Medial sesamoid is complete but exhibits surface weathering. The bone is rugose except for its anterior and medial facets. Anterior articular surface that

articulates with the distal end of MC5 is 37.6 mm in mediolateral width and 45.3 mm in dorsoventral length. This surface (AMSMC5) more circular than oval and smooth with little porousness along the borders. AMSMC5 has a dark, smoother circle of surface area in the center and close to the distal margin. Articular surface on the medial side of the medial sesamoid (MMSMC5) articulates with the medial side of the paired lateral sesamoid. MMSMC3 is 27.1 mm in dorsoventral length and 5.7 mm in anteroposterior width. On the lateral side, there are three large foramina. These foramina are clustered in the center of the lateral side. This medial sesamoid has the same tendon concavity encircling the bone as the other sesamoids.

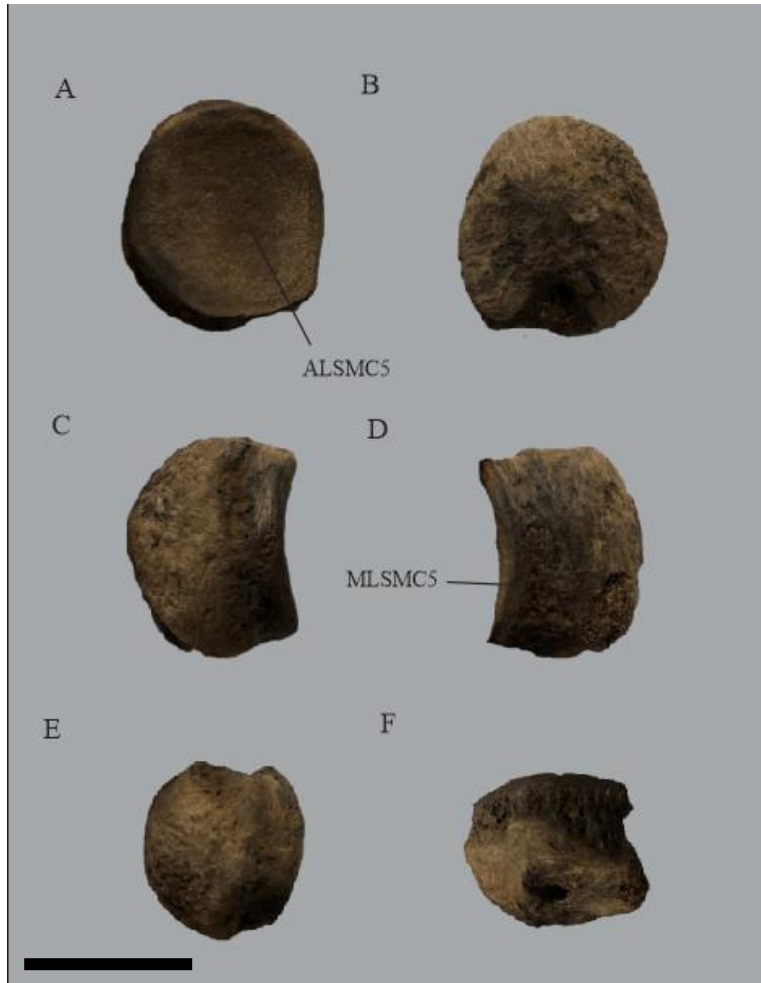


Figure 32: Left Metacarpal V lateral sesamoid of ETMNH 305. A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ALSMC5, anterior articular surface of the lateral sesamoid to metacarpal V; MLSMC5, medial articular surface to the lateral sesamoid to metacarpal V. Scale bar = 5 cm.

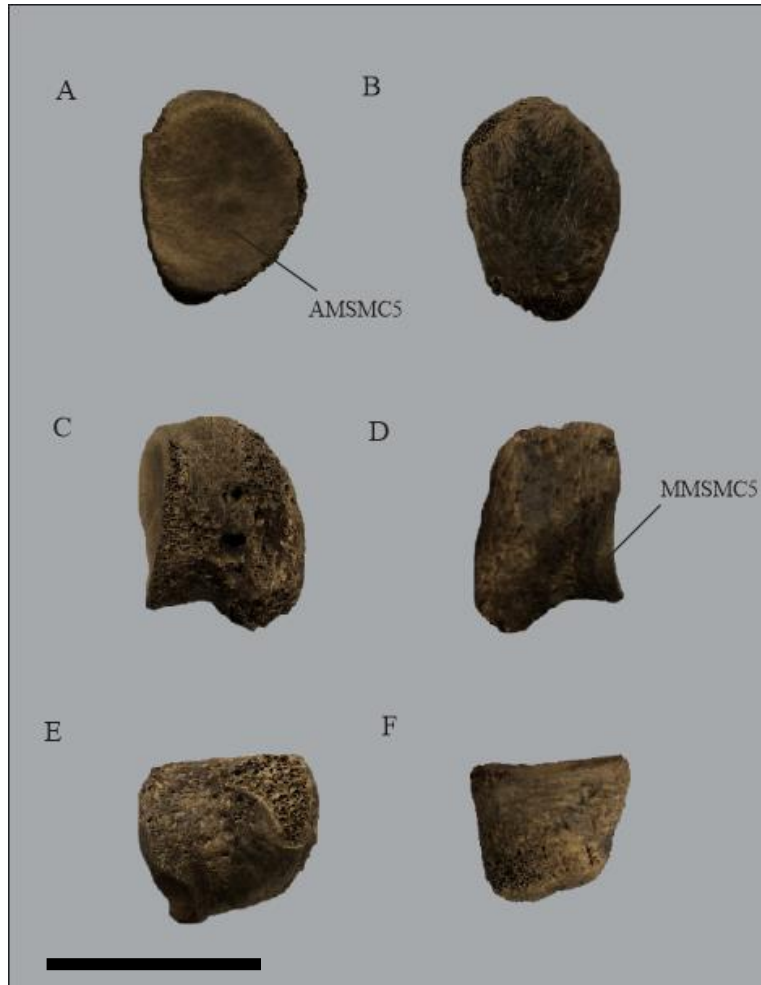


Figure 33: Left Metacarpal V medial sesamoid of ETMNH 305. A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. AMSMC5, anterior articular surface to the medial sesamoid of metacarpal V; MMSMC5, medial articular surface to the medial sesamoid of metacarpal V. Scale bar = 5 cm.

CHAPTER 4. *Mammut americanum* FROM AUCILLA RIVER

The American mastodon, *Mammut americanum* (UF 137891, AUC.R.3E) has both right and left manus elements.

Right Manus

Carpals

Trapezoid. The trapezoid (Figure 34) articulates proximally with the scaphoid, medially with the magnum, distally with the second metacarpal, and laterally with the trapezium. It is anteroposteriorly elongate and both mediolaterally and dorsoventrally narrow. Greatest anteroposterior length is 97.0 mm and its greatest mediolateral width is 73.0 mm. Trapezoid is entirely complete but with several thin cracks. Like many of the other carpals, it is generally triangular in shape with the posterior end creating the rounded point and the anterior end forming the base.

In dorsal view, the trapezoid shape is somewhat triangular. Medial outline has a strong undulatory curvature from the anteromedial corner to the posterior point, with the convex portion anteriorly oriented and the inward curvature beginning in the center of the medial side and rounding out to the posterior point. Anterior edge is a subtle convex curvature with the anteromedial corner more anteriorly extended than the anterolateral corner. Lateral side is greatly concave, and the posterior end is rounded. Most of the dorsal surface is comprised of the concave articular surface for the overlying scaphoid (ASS), except for some rugose posterior edge that extends past the termination of the ASS. ASS has the same shape as the overall carpal since it comprises its dorsal surface but its rounded posterior end is shorter than the carpal's. ASS is smooth except for its margins, which are slightly porous. Anterolateral corner has an oval

depression and the concave medial curvature exhibits a smoother surface where significant movement took place and caused wear on the bone. Lastly, there is an osteolytic pathology near the center of the medial side's convex portion of the undulating curvature. Pathology's edges are smooth.

In medial view, the trapezoid is rectangular. Dorsal and ventral outlines are slightly concave whereas the anterior and posterior outlines are slightly convex. There are also three different surface areas for articulation with the magnum's lateral side are combined into essentially one large connective articular surface: proximal (ASPM), anterior (ASAM), and distal (ASDM). ASPM is two oval articular surfaces that have connected at the point of greatest curvature. Overall anteroposterior length is 86.1 mm. The smaller posterior articular surface is about 33.7 mm in anteroposterior length with a dorsoventral height of 20.6 mm, which begins to narrow anteriorly as it joins with the larger anterior portion of the ASDM. ASAM is 21.5 mm in anteroposterior width at its center and is 54.4 mm in dorsoventral height. ASDM is comprised of three separate sections: the blocky distal end of the ASAM and a thin rectangular line of articular surface that connects it with the circular distal posterior articular surface. All of these surfaces connect, providing the ASDM with an anteroposterior length of 61.7 mm. The thin line of articular surface connecting the anterior and posterior portions is 5.4 mm in dorsoventral height, and the posterior articular surface is 18.9 mm in dorsoventral height and 19.62 mm in anteroposterior length.

All of the articular surfaces are smooth with little porosity apparent. There are two osteolytic features on the medial side. The first is located near the center of the ASPM in the larger anterior surface, and it has smooth edges. The second is near the distal end of the ASAM, close to the anterior edge, and is also smooth edged. Rest of the bone is rugose, concave, and has

foramina. Rugose anterior margin is present before the ASAM starts and there is a small rugose nodule near the posterior end. Bone between the articular surfaces is concave and has many small foramina.

In ventral view, the trapezoid is much slimmer than its dorsal counterpart. It is comprised entirely of the articular surface for the second metacarpal (ASMC2(2)). ASMC2(2)'S greatest anteroposterior length is 88.1 mm and its greatest mediolateral width is 40.9 mm. Articular surface is smooth with no visible porousness, but there is a small osteolytic pathology near the center of the anterior section. Anterior and posterior outlines are convex whereas the medial and lateral outlines are greatly concave, resulting in ventral shape much like a drumstick. Rugose bone from the medial side also extends outwards medially and past the articular surface in ventral view.

In lateral view, there is one most prominent articular surface for the trapezium (ASTM). Block shaped ASTM is on the anterior side and has a posteroventral tail that tapers to a distal corner near the posterior end. ASTM is 42.0 mm in anteroposterior width and 48.3 mm in dorsoventral height. Tapering distal articular tail is 34.7 mm in anteroposterior length and begins with a 16.8 mm dorsoventral height but tapers to a 2.7 mm dorsoventral height. Even in lateral view, the ASS is visible as it curves downward towards the lateral margin. ASTM connects with the ASS, sharing a proximal border at the trapezium's anterior on the lateral side. ASTM has a smooth circular stain in the anterocentral area.

In anterior view, the trapezoid is trapezoidal. Anterior margin is the larger base whereas the ventral margin is the smaller base, both of which are nearly flat. Medial and lateral sides are slightly convex, and the medial margin is larger than the lateral's. ASS lips down into the anterior side by a few millimeters, almost from the lateral to medial margins. The entire surface

beneath small lip of the articular surface for the scaphoid is rugose with many large and small foramina scattered about. Bone beneath the articular lip is slightly concave and has less foramina. Ventromedial corner has the most notable soft tissue fibrous webbing attachments on a subtle rugose nodule. Attachments cross to the ventrolateral corner, where the rugosity becomes smoother and foramina are absent.

In posterior view, the rugose posterior tip forms a rounded, soft tissue webbed, protrusion. On either side of the knot, the medial and lateral sides are visible as they expand outwards. Above the center of the posterior nodule, there is the triangular point where the ASS begins to dip laterally. The protrusion is riddled with foramina, with one large central foramen being proximally located.

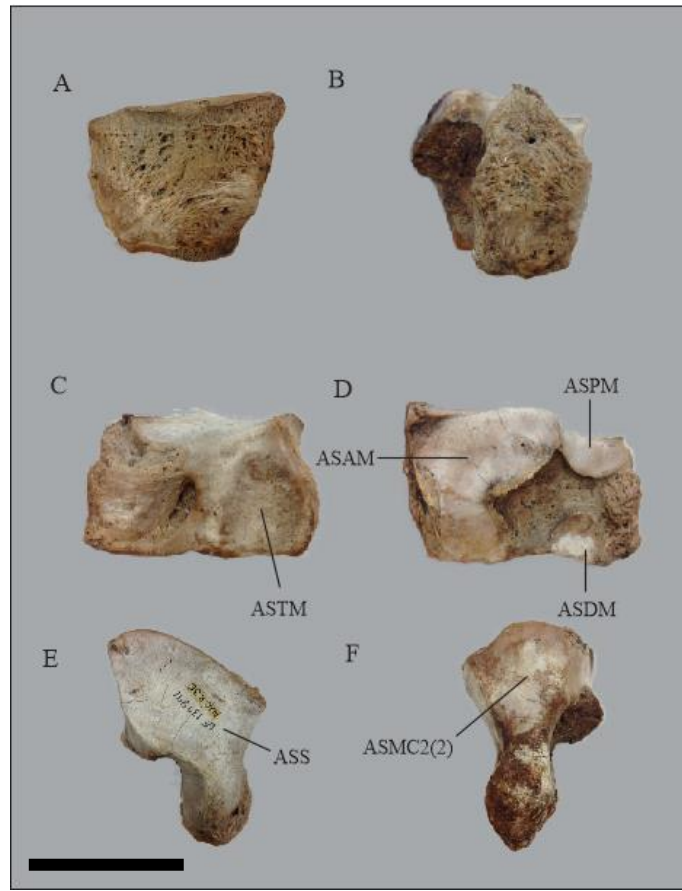


Figure 34: Right trapezoid of UF 137891.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASPM, Articular Surface of the Proximal Magnum; ASAM, Articular Surface of the Anterior Magnum; ASDM, Articular Surface of the Distal Magnum; ASTM, Articular Surface for the Trapezium; ASS, Articular Surface for the Scaphoid; ASMC2(2), Second Articular Surface for Metacarpal II. Scale bar = 5 cm.

Metacarpals

Metacarpal IV. The fourth metacarpal (MC4) (Figure 35) articulates proximally with the unciform, dorsomedially with the third metacarpal, laterally with the fifth metacarpal, and distally with the proximal phalanx associated with the fourth digit and two sesamoids. MC4 is dorsoventrally elongate and mediolaterally and anteroposteriorly narrow. Greatest dorsoventral height is 144 mm; greatest mediolateral width is 103.8 mm; and its greatest anteroposterior width is 112.0 mm. MC4 is largely complete but has several distally chipped articular surfaces.

In dorsal view, the shape of MC4 is triangular, with the anterior margin forming the base and the posterior end forming the rounded point. The entire dorsal surface is the articular surface that articulates with the distal articular surface of the unciform, or the ASMC4. This surface, ASUN 6 entirely smooth and not porous. Its central mediolateral width is 54.3 mm and its greatest anteroposterior length is 86.3 mm. Its anterior margin is subtly convex with a central apex, and the medial outline is slightly concave. Lateral margin is slightly convex and the posterior point is convexly narrow and rounded. There is a large foramen that sits in the posterior curvature, connecting with the articular border. A smooth rugose surface extends past the posterior margin. In dorsal view, the proximal articular surface on the medial side is also visible as it extends outwards medially. This articular surface articulates with the third metacarpal's proximal articular surface on its lateral side (ASMC4(2)). Articular surface (ASMC3(4)) shares an articular border with ASUN5. ASMC3(4)'s proximal articular border is the ASUN5's medial articular border. In dorsal view, the ASMC3(4) gives the MC4 a convex medial outline when included.

In medial view, the main feature is the proximal articular surface, ASMC3(4). This articular surface has a nearly straight proximal margin with a slight convexity, and the rest of the

articular border is a large convex curvature that is distally oriented. MC4's proximal margin is much the same as the ASMC3(4)'s. Posterior outline is deeply concave beneath its proximal extension before broadening back out to the posterior distal curvature for the sesamoids. Within the posterior concavity, there is also a small convex nodule. Anterior margin is also concave, though not as deeply as the posterior outline, and the concavity does not start until after an anterior rugose nodule. Like the posterior outline, the anterior outline widens back out for the ventral curvature, which is very convex and U-shaped.

Proximal articular surface is smooth with no porousness and the articular border is raised above the articular surface. ASMC3(4) is 65.4 mm in anteroposterior length and 34.3 mm in dorsoventral width. Distally, along the ventral U-shaped curvature, there is a smooth articular surface that rims the distal margin, which is partially chipped off posteriorly. The crescent-shaped articular surface is about 77 mm in anteroposterior length and has a maximal dorsoventral height of 18.0 mm. Between the two surfaces the bone is rugose and riddled with foramina, the larger ones contouring the articular margins. A small rugose ridge, starting anteriorly, decreases in size as it goes under the ASMC3(4) before terminating beneath its center. Bone on the medial side is only slightly concave beneath the ASMC3(4) before it flares back out towards the distal end.

In ventral view, the articular surface for the proximal phalanx for the fourth digit (AS4PP) is most prominent, and the two articular surfaces for the sesamoids are visible posterior to it. Sesamoid surfaces extend into the posterior view whereas the phalanx curve extends into the anterior view. AS4PP has a greatest anteroposterior length of about 82.1 mm and a greatest mediolateral width of about 84.8 mm. Greatest mediolateral width in the center of the phalanx and sesamoid articular surfaces is 73.4 mm. AS4PP is entirely smooth and light colored, but

there is a large, lighter circle that is raised above the rest of the AS4PP and is closer to the medial and anterior articular borders. Greatest dorsoventral length of the raised articular surface is 56.5 mm. Much of the central and lateral articular surface between the AS4PP and the sesamoid surfaces are chipped away.

In lateral view, there are two articular surfaces, similar to the medial side of the MC4. Proximal articular surface articulates with the proximal articular surface on the medial side of the fifth metacarpal, ASMC4(3). MC4's proximal articular surface (ASMC5(2)) is a long and thin oval facet. It is smooth with no porousness and its articular border is raised above the articular surface except near its anterior termination. It has an anteroposterior width of 69.2 mm and a dorsoventral length of 17.5 mm. Distally, along the ventral U-shaped curvature, there is a smooth articular surface that rims the distal margin. The crescent-shaped articular surface is about 63.8 mm in anteroposterior length and has a maximal dorsoventral height of 16.8 mm. Between the two surfaces the bone is rugose and riddled with foramina, the larger ones contouring the articular margins. Rugose bone is concave beneath the proximal articular surface but the bone on the lateral side quickly expands towards the distal end.

General shape of the MC4 is also similar to the medial side. Dorsal outline is slightly convex whereas the ventral outline is greatly convex, with a very anteroposteriorly wide U-shape. Posterior outline is greatly concave beneath is proximal posterior extension and it expands outwards again with the start of the U-shape distal end. There is not convex nodule in the center on the lateral side like there is on the medial. Anterior outline is also deeply concave, though to a lesser extent than the posterior outline. Its convexity is also limited to the proximal end as the distal end bulges out with the U contour.

In anterior view, the dorsal outline is concave, with the ASUN5 visible and curving down to the anterior articular border. Medial outline is moderately straight, and the lateral outline is concave, more so proximally. Ventral outline is subtly concave. Overall, the whole surface is rugose with large foramina following the convex curvature of the anterior portion of the AS4PP. Distal AS4PP curves up into the anterior plane and the articular border stays relatively flush with the articular surface. Anterior AS4PP is oriented more to the medial side. The only rugose protrusion is the slim one in the anteromedial corner, which curves into the medial side and beneath the ASMC3(4). A large foramen is near the proximal boundary of the rugose protrusion.

In posterior view, the medial and lateral sides are slightly concave proximally before flaring back out distally. Ventral outline is concave with the ridge between sesamoid articular surfaces representing the greatest depression. Medial corner extends more distally than the lateral. Most of the posterior bone is rugose and concave beneath the proximal posterior protrusion and above that sesamoid articular surfaces. Sesamoid facets curve into the posterior side from the ventral edge. Above them, the bone is smooth with rugose soft tissue attachment scars present around the smooth, non-articular, bone. There is a raised rim on the articular surface between the lateral and medial articular sesamoid surfaces (ASMS4 and ASLS4). This elevated ridge is closer to the lateral side, making the ASMS4 larger than the ASLS4. Dorsoventral length of the ASMS4 is about 47.1 mm and its mediolateral width is about 31.6 mm. Both measurements can be in error by a few millimeters due to chipping, making the values less than maximal. Greatest dorsoventral length of the ASLS5 is 45.5 mm, and its greatest mediolateral width is about 29.4 mm. Both sesamoid articular surfaces are smooth without any porosity; however, an osteolytic pathology is on the proximal rim of the medial sesamoid.

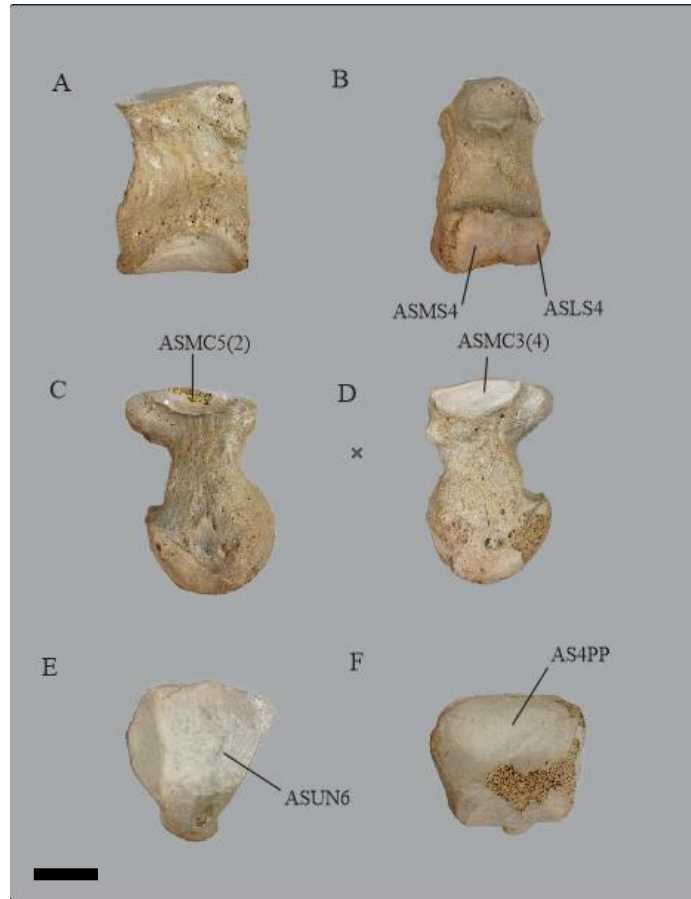


Figure 35: Right Metacarpal IV of UF 137891

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASMS4, articular surface for the medial sesamoid to metacarpal IV; ASLS4, articular surface for the lateral sesamoid to metacarpal IV; ASMC3(4), fourth articular surface to metacarpal III; ASMC5(2), second articular surface to metacarpal V; ASUN6, sixth articular surface for the unciform; AS4PP, articular surface for the proximal phalanx of digit IV. Scale bar = 5 cm.

Left Manus

Carpals

Cuneiform. The cuneiform (Figure 36) articulates proximally with the ulna, distally with the unciform, medially with the lunar, and posteriorly with the pisiform. It is mediolaterally elongate and anteroposteriorly and dorsoventrally narrow. Cuneiform's greatest mediolateral length is 131.5 mm, and its greatest anteroposterior width is 156.0 mm. Left cuneiform is entirely complete with just a few thin cracks.

In dorsal view, the cuneiform is triangular shaped with the medial edge forming the base and the lateral projection tapering to the rounded point. Anterior edge is very convex whereas the posterior outline greatly concave. Medial side is slightly concave, and the lateral tip is convexly rounded. Shape of the ASU is triangular, with the base being the cuneiform's medial side, and the point rounding out, with the rugose lateral projection extending beyond the rounded triangular tip. ASU shares an articular edge with the articular surface for the pisiform (ASP) that is on the posterior side. ASU is gently concave and smoothly centered with porous edges. Posteromedial corner is darker than the rest of the surface and elevated from it. Greatest mediolateral length of the ASU is 117.1 mm, and the greatest anteroposterior width of the ASU is about 88.7 mm.

In medial view, both the anterior and posterior outlines are convex, and the dorsal outline is concave. Ventral outline is undulating, with the convex portion anteriorly located. Anterior side is thicker than the posterior, and the ASU barely curves downwards into the cuneiform's medial side. Medial side has a distal articular surface for the lunar (ASL) that is roughly oval shape but tapers greatly posteriorly. In greatest anteroposterior length, the ASL is 68.5 mm and

the greatest dorsoventral height is 16.9 mm. Articular surface appears to be entirely smooth and flush with its articular borders. ASL's ventral border is the connective medial border for the articular surface for the unciform (ASUN), which is on the cuneiform's distal surface. Besides the ASL, much of the medial surface is concave and rugose with large foramina in anteroposterior center.

In ventral view, most of the surface is the articular surface for the unciform (ASUN), except for where the rugose bone on the posterior side curves ventrally, making it visible on the ventral side. ASUN is more square than triangular as it rounds out at the beginning of the lateral extension, with very little articular surface tapering along it. There is a osteolytic pathology close to the posterior side with smooth edges and no porousness or staining is noted. ASUN's greatest mediolateral length is 150.6 mm and its greatest anteroposterior width is 95.1 mm, when laterally tapers to about 27.9 mm.

In lateral view, most of what is visible is the rugose tip of the lateral projection that curves posteriorly. Some smaller foramina are also notable.

In anterior view, the ASUN edge has a generalized concave curve, and the ASU edge has an undulating contour. The entire anterior surface is rugose, though with less of a wrinkled appearance and more of a smooth, striated one with soft tissue attachment fibers. Larger foramina are centrally located, and foramina are absent along the dorsal and ventral margins. ASUN and ASU do not curve into the anterior's side.

In posterior view, the ASP is oval shaped and directed along the lateral projection to an extent. ASP connects with the posterior margin of the ASU and the rest of the ASP's articular rim is rounded. ASP is flat and smooth, flush with its border. Greatest mediolateral width for the

ASP is 46.8 mm and its greatest dorsoventral length is 53.3 mm. Beneath the facet for the pisiform, there is a small concavity just below the articular surface with several large foramina. Otherwise, the posterior side is rugose with a small knob of bone near the medial corner with a large foramen.

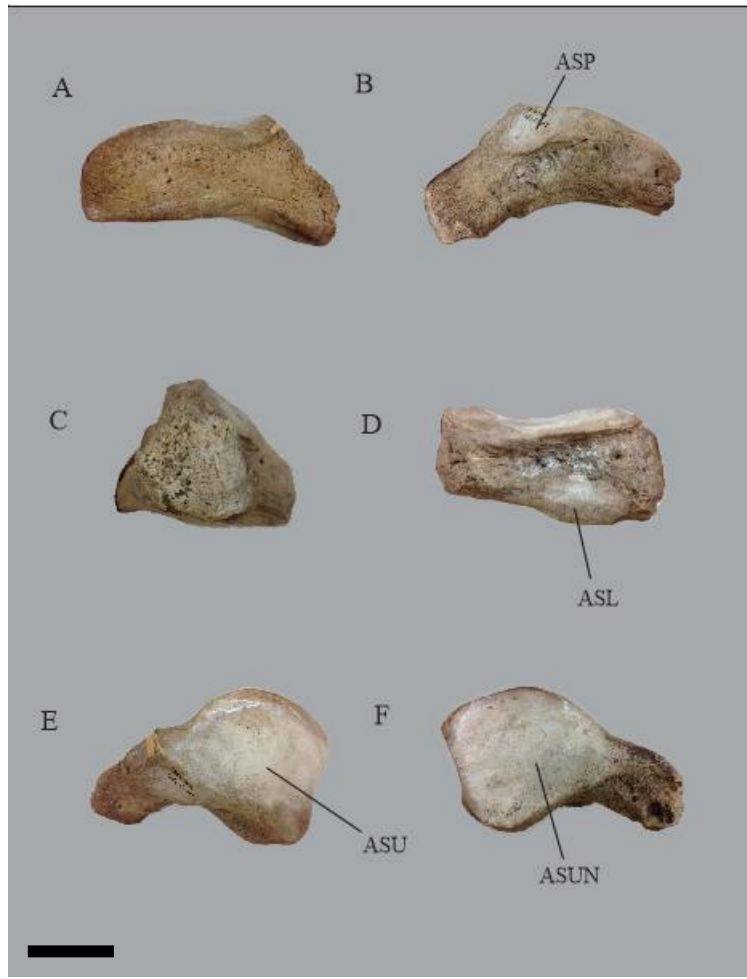


Figure 36: Left cuneiform of UF 137891.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASP, articular surface for the pisiform; ASL, articular surface for the lunar; ASU, articular surface for the ulna; ASUN, articular surface for the unciform. Scale bar = 5 cm.

Lunar. The lunar (Figure 37) articulates proximally with the radius, dorsomedially with the ulna, medially with the cuneiform, distally with the magnum, and laterally with the scaphoid. Lunar is anteroposteriorly elongate with the anterior mediolateral length nearly matching the anteroposteriorly length as a whole, but the mediolateral length narrows significantly towards the posterior extremity. Lunar is dorsoventrally short. Greatest anteroposterior length is 130.0 mm and the greatest mediolateral width is 123.0 mm. Left lunar is complete but has some thin cracks. The lunar is very triangular and looks much like a large bike seat with the anterior edge making the base and the posterior side comprising the very rounded point.

In dorsal view, the surface is almost entirely an articular surface for the distal radius. Its greatest anteroposterior length is 97.4 mm and its greatest mediolateral width is 102.9 mm. Anteromedial margin of the ASR is also the conjoined border margin for the ASU2 on the medial side of the lunar, which is not in proximal view. Anterior outline is slightly concave with the depression in its center. Medial side has a greater concave curvature with the greatest depression occurring posteriorly to the medial side's ASU2. After the centromedial depression on the medial side, the bone curves into a convexly rounded posterior curvature; however, the posterior curvature does have a small central dip. ASR is very smooth in its center and posterior areas and has a large osteolytic pathology near the center of its lateral edge. Anteromedially, the ASR surface is elevated, rough, and darkly colored, probably indicating less movement in that area.

In medial view, there are two articular surfaces: the proximal ASU2 and the distal articular surface for the cuneiform (ASC). ASU2 is very circular with a raised center. Before the upraised articular border for the ASU2, the surface depresses. ASU2's greatest anteroposterior length is 60.1 mm and its greatest dorsoventral height is 41.4 mm. No porousness is apparent.

Distally, the ASC is moderately flat. ASC is 71.6 mm anteroposteriorly wide and 14.1 mm dorsoventrally tall anteriorly and 6.0 mm posteriorly. Area between the ASC and ASU2 is very concave and many foramina are visible in the posterior rugose concavity, which extends to the posterior point of the bone where it ends at a ball like nodule. On both the dorsal and ventral edges surrounding the articular surfaces, the outline of the bone in medial view is concave, more so ventrally. Anterior side is slightly convex, and the posterior point is very convexly rounded.

In ventral view, the articular surface for the magnum (ASM) takes up the entirety of the bone surface. It is greatly concave from the posterior point up to where the facets appear on the lunar's medial and lateral sides, which is where the rest of the bone up to the anterior side becomes convex. The surface is smooth except for its anterolateral corner which is darker and somewhat porous. Close to the center of the ASM, there is a large osteolytic pathology with smooth edges. Magnum is mostly triangular in ventral view, with a nearly straight lateral edge, a slightly concave anterior outline base, a stronger concaved medial outline, and a convex posterior curvature.

In lateral view, the bone is relatively flush with the scaphoid's articular surfaces. Rugose bone between the lunar's scaphoid articular surfaces has very little concavity. Foramina are visible in the rugose center. For the overall shape in the lateral viewpoint, the posterior end is convex and well-rounded whereas the anterior end is slightly concave. Dorsal edge of the bone is concave whereas the ventral edge is concave from the posterior point to the beginning of the ventral articular surface for the scaphoid (VASS), where the bone becomes relatively flat from there to the anterior border. Dorsal articular surface for the scaphoid (DASS) is long and thin. It is anteroposteriorly 66.8 mm long and about 10.6 mm in dorsoventral height. VASS is oval

shaped. This articular surface is about 52.9 mm long anteroposteriorly and has a greatest dorsoventral height of 19.4 mm. Both surfaces are smooth and flush with their articular borders.

In anterior view, the anterior side is somewhat flat except for where a bony ridge extends anteriorly outwards on from the lateral side to its center. Otherwise, the bone is rugose with many foramina scattered about, but absent along the concave ventral and dorsal margins. Both the medial and lateral sides are convex.

In posterior view, the point is very rugose with many foramina visible.

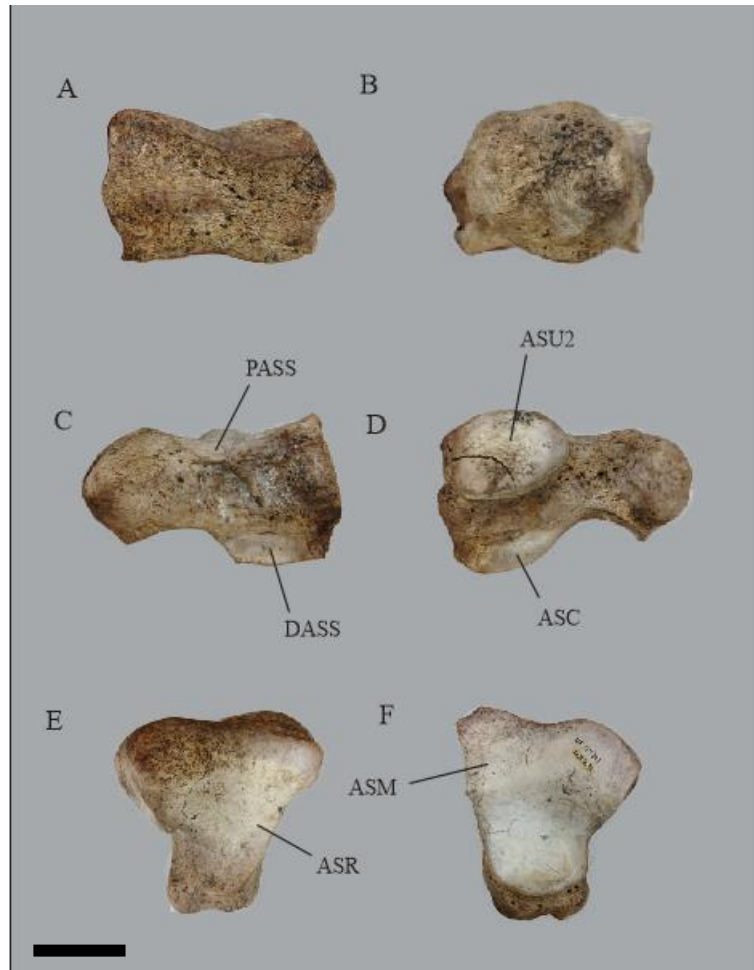


Figure 37: Left lunar of UF 137891.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. PASS, proximal articular surface for the scaphoid; DASS, distal articular surface for the scaphoid; ASU2, second articular surface for the ulna; ASC, articular surface for the cuneiform; ASR, articular surface for the radius; ASM, articular surface for the magnum. Scale bar = 5 cm.

Scaphoid. The scaphoid (Figure 38) articulates proximally with the radius, laterally with the lunar, and distally with the magnum, trapezoid, and trapezium. It is dorsoventrally and anteroposteriorly elongate but narrow mediolaterally. Its greatest dorsoventral length is 121.0 mm; its greatest anteroposterior length is 106.0 mm; and its greatest mediolateral width is 72.0 mm. It is complete with only a few small cracks. Like most of the other carpals, its general shape is triangular. It is a really well rounded, fat triangle, with the base being the ventral side and the point being the tip of the dorsal articular surface for the radius (ASR2); however, the dorsal facet makes a sharp diagonal in the triangular shape, making it look like part of the rounded anterior edge is cut off.

In dorsal view, the circular ASR2 is the most prominent observable feature, though the convex posterior edge and the extended ventral articular surface for the lunar (ASL2) facet are also visible around ASR2. Dorsal articular surface for the radius has a conjoined rim that connects with the proximal articular surface on the scaphoid's medial side, which articulates with the proximal articular surface on the lunar's lateral side. This conjoined articular surface is ASL3 and the shared border with ASR2 is porous. Greatest anteroposterior length of the ASR2 is roughly 65.5 mm and its greatest mediolateral width is 47.7 mm. The surface is smooth and light colored in the center and rougher in texture along the edges, especially the proximal rim.

In medial view, three articular surfaces are visible: ASL2, ASL3, and the articular surface for the magnum, trapezoid, and trapezium (ASMTDTM). The oval ASL2 is smooth and the articular surface is flush with the articular rim. Greatest anteroposterior length of ASL2 is 53.8 mm and its greatest dorsoventral height is 21.8 mm. Distal articular surface edge of ASL2 is shared by the medial edge of the articular surface for the magnum, trapezoid, and the trapezium on the scaphoid's ventral side (ASMTDTM). This shared articular rim is only slightly porous

from possible wear. ASL3 is long and slender, with an anteroposterior length of 50.4 mm and a dorsoventral height of 13.0 mm. The surface is smooth and the articular border is flush with the articular surface. ASMTDTM is on the scaphoid's distal surface but it curves slightly up into the medial side and is also smooth with no porousness visible and its surface is flush with its border.

In ventral view, the ASMTDTM is most prominent feature. ASMTDTM has its greatest anteroposterior length at 66.4 mm and its greatest mediolateral width at 41.6 mm. Articular surface is oval with an indent in the center of the lateral border. The surface is entirely smooth and flush with its articular borders. Besides the anterior outline, rugose bone expands outwardly from the ASMTDTM on the medial, posterior, and lateral sides. Large foramina are present in the expanded medial and posterior rugose bone, closely boarding the articular rims.

In lateral view, the entire surface of bone is rugose and many foramina are observable, especially distally. Dorsal outline forms a flat edge running from the posterior side and down to the anterior. Posterior outline is convex whereas the anterior outline is anterior, and the ventral outline is also convex. No rugose ridges or nodules protrude but many soft tissue attachment areas are visible, especially posteriorly.

In anterior view, the rounded anterior edge is all that comprises the scaphoid's anterior side. Part of the ASR2 is proximally apparent as is the anterior end of the ASL2. Above the ASL2 is a bony growth that extends anteriorly. Rest of the bone is rugose with small foramina.

In posterior view, a large, convexly curved edge between the lateral and medial sides is all that is present. There is an articular surface lip that curves from the ASR2 into the posterior side. This articular surface is 51.2 mm in mediolateral length and has a 14.5 mm in dorsoventral height. There is a rugose bone nodule that extends medially from the center of the posterior

side's medial edge. The rugose posterior ridge is entirely made up of fibrous soft tissue attachment threads, some webbed and some parallel. Posterior edge's greatest convexity is located near its ventral limit. Many small foramina are scattered about on this curvature. There are three large foramina as well, one oriented proximally, centrally, and distally.

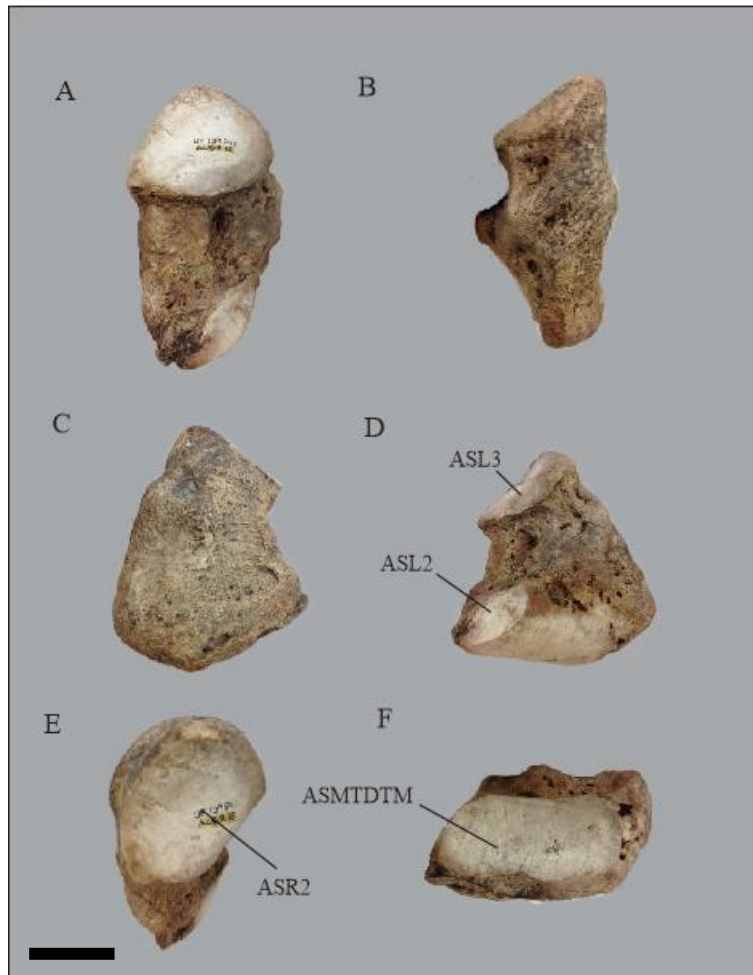


Figure 38: Left scaphoid of UF 137891.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASL2, second articular surface for the lunar; ASL3, third articular surface for the lunar; ASR2, second articular surface for the radius; ASMTDTM, articular surface for the magnum, trapezoid, and trapezium. Scale bar = 5 cm.

Unciform. The unciform (Figure 39) articulates proximally with the cuneiform, medially with the magnum, ventromedially with the third metacarpal, distally with the fourth metacarpal, and laterally with the fifth metacarpal. Unciform is mediolaterally and anteroposteriorly elongate, and dorsoventrally shorter. Greatest mediolateral width is 131.0 mm, whereas the greatest anteroposterior length is 116.0 mm. Unciform is complete with some small cracks.

In dorsal view, the shape of the unciform is very square. The entire dorsal surface articulates with the cuneiform (ASC2), but there is rugose bone posterior to the ASC2. Anterior outline is convex whereas the medial and lateral outlines are concave. Posterior outline is undulating with the posterolateral side being convex and then curving inwardly to the posteromedial corner. The round rugose posterior point is in the center of the posterior outline. ASC2 surface does not have much of an arch, but the greatest doming is posteriorly oriented. ASC2 is mostly smooth but with a porous and darkly stained posteromedial section. Articular rims are flush with the articular surfaces, and there is a tiny osteolytic pathology in the small posterolateral dome with smooth edges.

In medial view, the unciform is trapezoidal. The longer base is the rounded posterior side and the smaller base is the flat anterior side. Both the ventral and dorsal sides are concave. In the medial view, the articular surface for the magnum (ASM3) is quite prominent. Dorsal edge of the proximal articular surface (ASM3), shares a conjoined facet border with ASC2's medial edge. ASM3 is long, broad, and flat with a concave ventral edge. Its greatest anteroposterior length is approximately 87.0 mm and its greatest dorsoventral height is 55.8 mm on the posterior end whereas its minimal dorsoventral height, in the central area, is about 42.4 mm. distal articular surface for the third metacarpal (ASMC3) is vague, blending with the rugose bone above it. distal articular surface is associated with the ASMC3. ASMC3 is located on the ventral side but

it has a small section that is curved up into the medial side that is short and slender. It is about 42.3 mm in anteroposterior length and its greatest dorsoventral height is about 10 mm. ASMC3 has a flat ventral edge but a convex dorsal curvature. area between the ASM3 and ASMC3 is concave and rugose with foramina. The concavity is closer to the proximal surface and the central bone is almost flat and connective between the two surfaces anteriorly.

In ventral view, the unciform is triangular and square. Ventral articular surface is for the fourth metacarpal (ASMC4) centrally, and the ASMC3 medially. Articular surface that articulates with the fifth metacarpal (ASMC5) on the lateral side of the unciform is also visible in ventral view. The three large articular surfaces give the unciform's distal surface a relatively square shape. Medial outline has a flat edge before curving into the almost flat anterior outline, which is more anteriorly extended at the lateral corner. Lateral side is slightly convex and the dorsal outlines of the three surfaces are convex and all connect. Unciform appears triangular as well due to the large and rounded posterior point that extends posteriorly from the ASMC4 and ASMC3. Both the ASMC4 and the ASMC3 curve proximally at their posterior margins where they are darker in color. ASMC3 is flat and the ASMC4 is slightly concave. Shared articular border between the two is porous. ASMC3's greatest anteroposterior length is 82.7 mm and its greatest mediolateral width is 35.1 mm. ASMC4's greatest anteroposterior length is 80.6 mm and its greatest mediolateral width is 54.0 mm.

In lateral view, the shape is somewhat rectangular. Anterior side is mostly flat but with the slightest convexity, which is the same for the ventral outline. Dorsal outline is slightly convex near the anterior side but proximally curves into a sharper triangular point before inwardly curving towards the large rugose posterior. Posterior is convex with the greater extremity distally oriented. Articular surface on the lateral side is for the articulation of the fifth

metacarpal (ASMC5). Main body of the articular surface is rectangular with subtly convexly curved anterior, dorsal, and posterior edges, and a concave ventral outline; however, there is a proximal articular extension to this articular surface that shares the main dorsal edge. The extension is depressed from the main surface and is proximally curved. The total ASMC5 is 81.9 mm in anteroposterior width and is 56.1 mm in dorsoventral length. Proximal extension has a anteroposterior width of 74.5 mm and a dorsoventral height of 33.7 mm. A osteolytic pathology is posteriorly located on the raised portion of the ASMC5, and the surface is smooth, unlike the less used proximal extension, which is dark and rough.

In anterior view, the bone is very rugose and has many foramina. Larger foramina are along the dorsal edge and in the mediolateral center. Anterior side is moderately rectangular, and the face is flat. The medial side is dorsoventrally thicker and distally concave. Dorsal and lateral outlines are convex and the ventral outline is concave, until the ventromedial becomes flat and diagonally runs from the ventral margin and up to the medial side.

In posterior view, the unciform shape is triangular, with the base formed by the dorsal side and the point being the ventral and posterior rugose knot of bone. The entire side is rugose and many large foramina are scattered throughout. Fibrous soft tissue attachment webbing seems to sinuate the posteroventral nodule and stretches out over the rest of the bone surface.

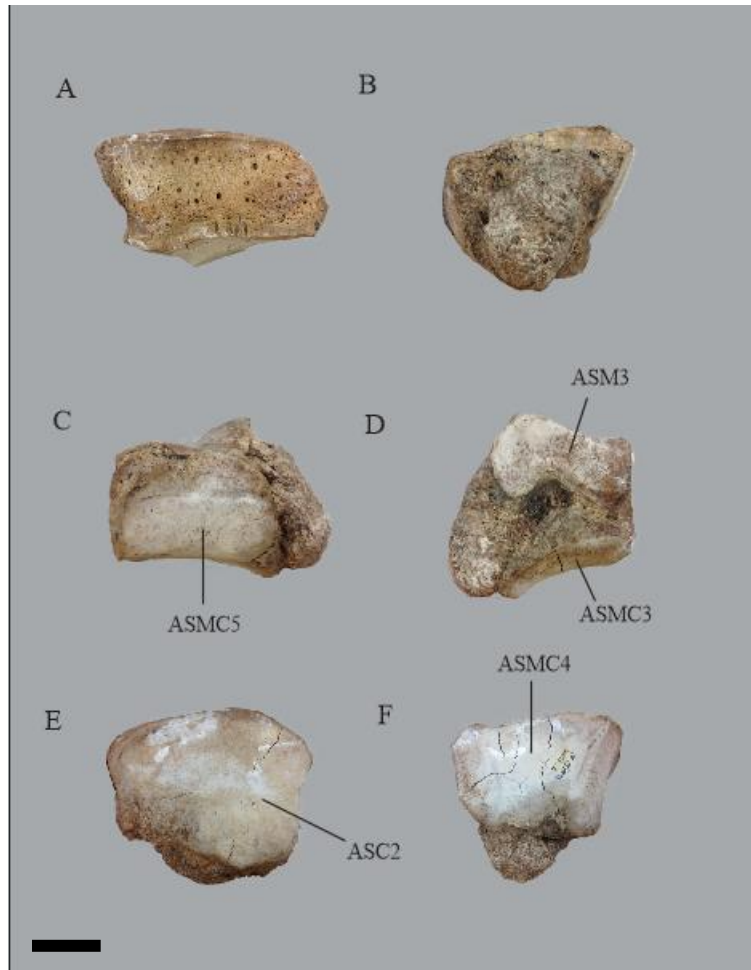


Figure 39: Left unciform of UF 137891.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASM3, third articular surface for the magnum; ASMC3, articular surface for metacarpal V; ASMC4, articular surface for metacarpal IV; ASMC5, articular surface for metacarpal V; ASC2, second articular surface for the cuneiform. Scale bar = 5 cm.

Magnum. The magnum (Figure 40) articulates proximally with the lunar, medially with the unciform, distally with the third metacarpal, and laterally with the trapezoid. Magnum is anteroposteriorly elongate and mediolaterally and dorsoventrally narrower. Greatest anteroposterior length is 120 mm, and the greatest mediolateral width is 101 mm. Overall magnum shape is square and blocky. The magnum is complete with some small cracks.

In dorsal view, the entire surface is comprised of the articular surface for the lunar (ASL4). ASL4 mostly flat, especially the anterior portion, but the posterior end does have slight doming. Medial side of the ASL4 is straight but the anterior edge has an undulating curve where it starts out curved anteriorly outwards on the medial side but begins a downward descent towards the lateral side. Lateral outline is very concave and the posterior side is slightly convex from the small posterior dome, but would otherwise be moderately straight edged. Overall, the ASL4 is smooth with some porous wear along the edges. The small posterior dome has a large osteolytic pathology and a smaller osteolytic pathology is located along the medial margin, posterior of the center. Like the same features on the other carpals, the round edges are smooth.

In medial view, the shape is trapezoidal, with the larger and rounded base being the posterior curvature and the anterior side comprising the smaller and flat base. Dorsal and ventral outlines have concave curvatures. Proximal articular surface (ASUN2) correlates with the proximal articular surface on the unciform's medial side. The smooth ASUN2 stretches from the anterior edge to the posterior edge and has a circular posterior and anterior end, a deeply concave ventral border, a slightly concave dorsal border, and a flat anterior edge. ASUN2's anteroposterior length is 87.0 mm and its anterior, central, and posterior dorsoventral heights are 44.1 mm, 30.6 mm, and 57.1 mm respectively. The smooth distal articular surface correlates with the third metacarpal's dorsal articular surface (ASMC3(2)). ASMC3(2) is crescent shaped, long,

and slender. Based on the articular surfaces present, the anteroposterior length of ASMC3(2) is 42.5 mm, but this articular surface would have been about 63 mm if the chipped posterior surface was available. Its greatest dorsoventral height is about 15.1 mm. Anteriorly, the two articular surfaces are nearly connected, separated only by a small area of smooth rugose bone that joins them. Rest of the bone between the two articular surfaces, centrally and posteriorly, is rugose, concave, and has a large single foramen in its center. Posteriorly there is a large rugose protrusion that has curved medially into the medial view from the posterior side. The rugose knob is riddled with medium to large foramina. Anteriorly there is a triangular distal section of rugose bone between the articular surfaces that terminates at their connective point.

In ventral view, the main articular surface is for the third metacarpal's proximal articular surface, also ASMC3(2); however, the articular surface for the second metacarpal (ASMC2) is also visible and this surface curves upwards towards the lateral side from the ASMC3(2). ASMC3(2) is 71.5 mm in greatest anteroposterior length and 50.6 mm in greatest mediolateral width. ASMC2 is 74.8 mm in anteroposterior length and 33.3 mm in greatest mediolateral width. Shape of the magnum is triangular with the posterior knobby protrusion and blocky with the articular surfaces. Anterior edge is convex, and the medial and lateral outlines are concave, the lateral side more so. Posterior outlines of the articular surfaces are both convex but join at a concave point posteriorly between them. Both of the articular surfaces are smooth and their connective border is a depressed, thin, channel between them. Posterior to the articular surfaces is the rugose protrusion forming a posteroventral apex.

In lateral view, the shape is square. Anterior side is mostly flat except for a distal ridge of rugose bone that extends anteriorly. Dorsal outline is undulating with the posterior dome becoming convex whereas the anterior is nearly flat. Posterior outline is concave beneath the

proximal articular surface in lateral view, but greatly extends to the posteroventral rugose knob. The ventral margin is mostly a subtly concave curvature. There are three articular surfaces that are combined in lateral view: the proximal, anterior, and ventral facets all connect. Proximal articular surface articulates with the proximal articular surface on the trapezoid's medial side (ASPTD). Likewise, this same pattern corresponds with the anterior and distal articular surfaces between the magnum and trapezoid resulting in ASATD and ASDTD. ASPTD's dorsal edge is slightly convex, its posterior end is rounded, its central margin is deeply concave, and its anterior edge is moderately flat. ASATD's edges are all relatively straight except for posterior outline which comes to an anteriorly directed triangular point in the center and the sides connect to the proximal and distal articular surfaces. ASDTD has a straight and flat dorsal edge, a greatly concave dorsal margin, a rounded and triangular posterior end, and a flat anterior side. Connecting the triangular posterior articular surface with the rest of the ASATD is a thin line of distal articular bone. The surface of bone that is not articular is rugose and concave, with foramina. The concave central is triangular in shape with the point directed at the ASATD. The triangular base narrows as the posterior sections of the ASPTD and ASDTD point towards each other. All the surfaces are smooth, but the central area of the ASPTD has three large osteolytic features clustered together. Also visible, distal to the ASDTD is the ventral side's articular surface for the second metacarpal (ASMC2).

ASPTD has an anteroposterior length of 83.9 mm and a greatest mediolateral width of 22.7 mm. ASATD has an anteroposterior length of 20.0 mm in the center and a dorsoventral height of 58.3 mm. ASDTD has a anteroposterior length of 64.7 mm. Anteroposterior length of just the thin connective articular surface and the posterior section is 40.3 mm. Posterior section

has a dorsoventral height of 18.6 mm and the connecting articular line has a dorsoventral of 6.4 mm.

In anterior view, the bone is rugose and mostly flat except for a small nodule at the ventrolateral corner where soft tissue attachment fibers stretch from and to the center of the anterior face. Large foramina encircle the knob and are also scattered about the rest of the rugose surface. Foramina are mostly absent along the proximal and distal margins. Dorsal and ventral outlines appear flat, as does most of the medial side except for a small dip in the bone close to the ventromedial corner. Ventrolateral section forms a straight edge from the ventral margin and up to the lateral side, with the lateral side exhibiting the smallest concave curvature.

In posterior view, the magnum's shape is mostly triangular. ASL4 makes the base and the posteroventral apex becomes the point with the medial and lateral edges making slightly concave sides. ASL4 curves downwards into the posterior side, only slightly. Apex of the ASL4 rounds out just off center on the more lateral side of the posterior surface. When the carpals are articulated, the only the posterior point of the ventral lunar surfaces covers the dorsal articulation that has curved into the posterior side. Corners of the dorsal facet are left uncovered by the lunar. Medial corner gets partially covered by the ventral cuneiform as it connects with the lunar and on the lateral side, that posterior corner gets covered by part of the scaphoid as it connects with the lunar. Beneath the ASL4 in the posterior side, the rugose bone is slightly concave, and the posterior side is mostly rugose bone, besides the ASL4. Large foramina are scattered about and the most rugose protrusion is the most notable feature with several soft tissue attachments interweaving around it as its distally directed.

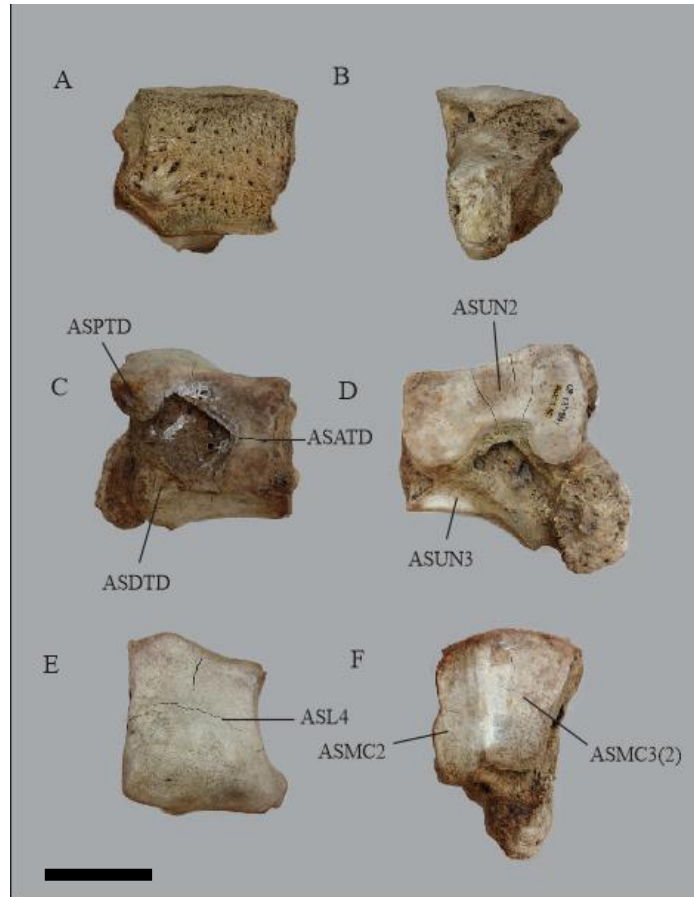


Figure 40: Left magnum of UF 137891.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASPTD, articular surface of the proximal trapezoid; ASATD, articular surface of the anterior trapezoid; ASDTD, articular surface of the distal trapezoid; ASL4, fourth articular surface of the lunar; ASMC2, articular surface for metacarpal II; ASMC3(2), second articular surface for metacarpal III; ASUN2, second articular surface for the unciform; ASUN3, third articular surface for the unciform. Scale bar = 5 cm.

Trapezium. The trapezium (Figure 41) articulates proximally with the scaphoid, medially with the trapezoid, and laterally with the first metacarpal. It is anteroposteriorly elongate and the mediolateral and dorsoventral axis are nearly equal in length. Trapezium's greatest mediolateral length is 68.0 mm; its greatest dorsoventral height is 63.0 mm; and its greatest anteroposterior width is 72.0 mm. General shape of the trapezium is a cylinder. Trapezium is complete with some thin cracks.

In dorsal view, there is only one articular surface (ASS), which associates with the overlying scaphoid. It is very oval in shape. Medial edge is medially convex and the rest of the outline curves convexly laterally into the rugose area. It is 32.7 mm anteroposteriorly length and has its greatest mediolateral wide at 20.3 mm. Rest of the medial surface is rugose and flat with several medium sized foramina scattered about. In dorsal view, the medial and lateral edges are flat, with the lateral side being straight and the medial side being diagonal with the elevated end posteriorly oriented. Anterior outline is concave whereas the posterior outline is convex.

In medial view, there is only the articular surface for the lateral side of the trapezoid (ASTD). ASTD dorsal's edge is straight, which is also the conjoined medial edge of the ASS2, and the rest of the surface forms an elongate oval. The entire surface is darkly stained and porous and flush with its articular borders, except for the posterior edge where the border is depressed from the surface. ASS2's overall anteroposterior width is 44.5 mm and its greatest dorsoventral height is 60.9 mm.

In ventral view, the rugose bone surface is relatively flat with a single large foramen near the center. Many soft tissue attachment fibers are visible and are directed towards a smoother rugose surface near the ventral margin. Medial and ventral outlines are flat whereas the posterior and anterior outlines are concave.

In lateral view, there is only the circular articular surface for the first metacarpal (ASMC1). ASMC1 is very round and has a raised center. Dorsoventral diameter length is about 63.6 mm and 58.3 mm transversely. The raised central surface is 56.8 mm in dorsoventral length and 39.4 mm in anteroposterior width which tapers to about 30 mm anteriorly. ASMC1's anteriorly rimmed border is raised but the rest of the articular border is flush with the articular surface. The surface is smooth in the raised center but porous around it. In the posterior section of the raised articular surface, a large osteolytic pathology is centrally located, with crack branching from it. Its edges are smooth and the bone around it is a darker color and slightly depressed from the surrounding surface.

In anterior view, the bone is very blocky with nearly moderately flat edges and curved corners. The anterior bone is deeply concave and entirely rugose with large foramina laterally located.

In posterior view, the shape is similar to the anterior's. The bone is totally rugose and has a raised central ridge that stretches the dorsoventral width. There is also a slight rugose nodule near the lateral margin. Several large foramina follow along the ridge as well as soft tissue attachment fibers.

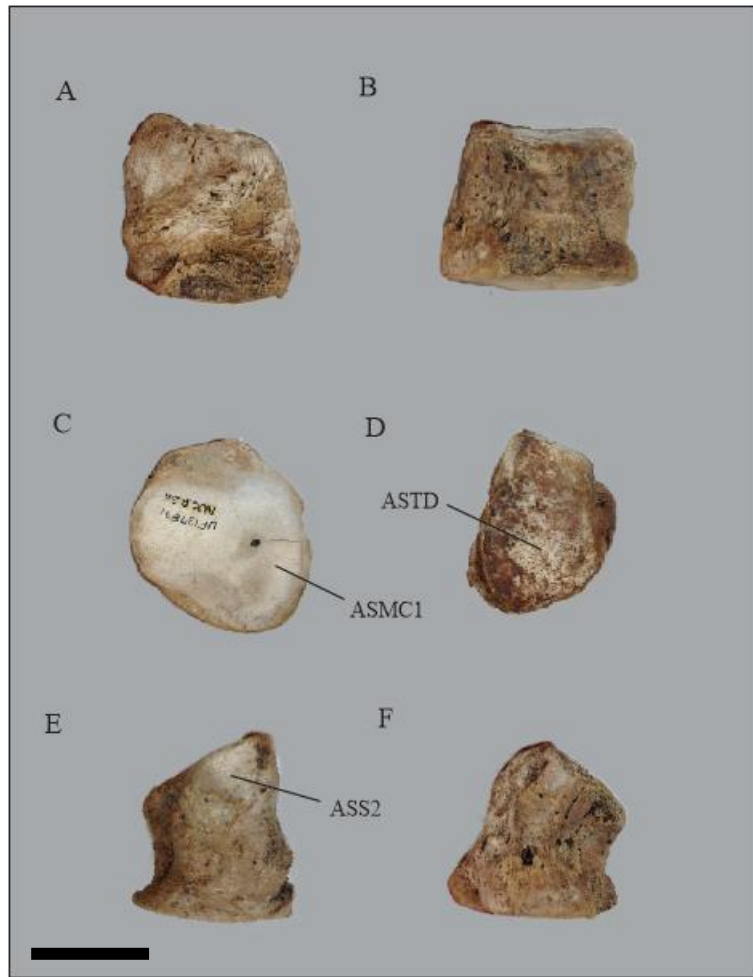


Figure 41: Left trapezium of UF 137891.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASMC1, articular surface for metacarpal I; ASTD, articular surface for the trapezoid; ASS2, second articular surface for the scaphoid. Scale bar = 5 cm.

Metacarpals

Metacarpal I. The first metacarpal (MC1) (Figure 42) articulates proximally with the trapezium, and distally with the proximal phalanx for the first digit and two sesamoids. MC1 is dorsoventrally elongate, with narrow mediolateral and anteroposterior axes. Greatest dorsoventral length of MC1 is 111.0 mm; its greatest anteroposterior width is 88.0 mm; and its greatest mediolateral width is 72.0 mm. Right MC1 is complete with only a few hairline cracks present on the articular surfaces.

In dorsal view, rugose posterior bone and the articular surface for the trapezium (ASTM2), are observed. ASTM2 is mostly flat with the posterior side just barely elevated above the anterior. ASTM2's anteroposterior length is 72.3 mm and the mediolateral width is 56.5 mm. The smooth oval surface, which narrows anteriorly, has a raised center that has an anteroposterior length of 59.4 mm and a mediolateral width of 35.3 mm. In the center of the ASTM2, there is a tiny osteolytic pathology with smooth edges and the surround surface is depressed and dark around the hole. Outside of the smooth raised articular center, the bone is porous, and the rest of the articular surface is darker and flush with the articular borders. Posterior to the ASTM2, there is a large rugose ridge that stretches from the medial side to the lateral side and has many small foramina and some medially apparent soft tissue attachment fibers.

In medial view, the anterior and posterior curvatures are concavely inward into the MC1 shaft. AS1PP makes the distal contour distally convex and U-shaped, and the dorsal outline is flat. There is no proximal articular surface, but there is a distal articular surface that curves upwards from the MC1's ventral side and follows the shape of the distal curvature. Articular surface's anteroposterior length is 55.3 mm and its dorsoventral width is 19.2 mm. Large

foramina follow this outline of the articular surface posteriorly, and the rest of the medial side's bone is rugose. The anteroposterior center is slightly concave with a single large foramen in its center.

In ventral view, the AS1PP is the most prominent feature and is smooth. Its greatest mediolateral is 43.3 mm and its greatest dorsoventral length is about 52.1 mm. Center of the surface is lightly colored and smooth whereas the rest of the articular surface is dark. Lateral and dorsal articular borders are raised above the surface but the rest of the articular rims are flush with the articular surface. In the center of the distal surface, there is also a band of dark smooth surface between the light AS1PP and the light colored sesamoid articular surfaces, which extend into the posterior side of the MC1. This band of bone is 47.6 mm anteroposteriorly width and 54.5 mm mediolaterally wide.

In lateral view, the overall shape reflects that described for the medial side and the bone is rugose with no articular surfaces. Proximal posterior corner is very rugosely bulbous and smoother than the rest of the rugose lateral side. MC1 shaft is concave beneath the posterior protrusion and above a distally extended ridge of bone. Foramina are numerous.

In anterior view, the medial, lateral, and ventral outlines curve concavely inwards and the ASTM2 is visible slanting from the posterior edge down to the anterior. The bone is rugose with numerous foramina present, with a large foramen along the convex dorsal edge of the AS1PP. AS1PP curves up into the anterior view and its convex apex is off center, and more on the medial side. Mediolateral center of the anterior bone is concave with a proximal medial rugose nodule.

In posterior view, the shape of the MC1 is reflected of that described in the anterior viewpoint. Posterior side of the MC1 is rugose except for the two ventral sesamoid articular

surfaces. Proximally, there is a large rugose ridge of bone spanning the mediolateral width. The ridge has several soft tissue attachment fibers running dorsoventrally. MC1 is concave beneath the ridge before curving back out at the sesamoid surfaces. The same sesamoid articular surfaces are also visible on the ventral side but their greater surface area is within the posterior plane where they curve up into from their connection with the AS1PP. There is a cleft between the articular surface for the lateral sesamoid (ASLS1) and the articular surface for the medial sesamoid (ASMS1) with a large osteolytic pathology located in the cleft at its proximal border. ASMS1 is larger than the ASLS1. ASMS1 has a mediolateral width of about 24.4 mm and a dorsoventral length of about 40.5 mm. ASLS1 has a mediolateral width of 26.7 mm and a dorsoventral length of 35.6 mm. The surfaces are smooth and flush with their articular borders.

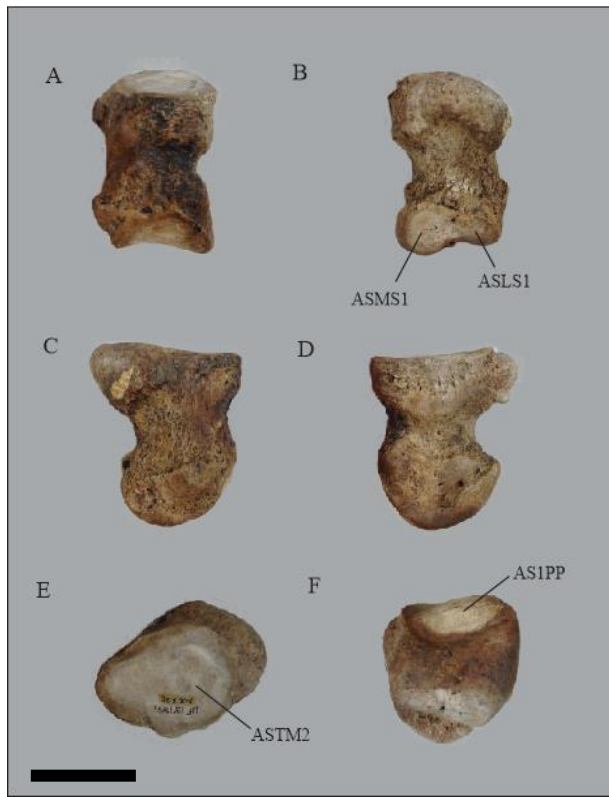


Figure 42: Left Metacarpal I of UF 137891.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASMS1, articular surface for the medial sesamoid of digit I; ASLS1, articular surface for the lateral sesamoid of digit I; ASTM2, second articular surface for the trapezium; AS1PP, articular surface for the proximal phalanx of digit I. Scale bar = 5 cm.

Metacarpal II. The second metacarpal (MC2) (Figure 43) articulates proximally with the trapezoid, dorsomedially with the magnum, medially with the third metacarpal (MC3), and distally with the proximal phalanx for the second digit (AS2PP) and two sesamoids. As a typical metacarpal, the MC2 is dorsoventrally elongate and mediolaterally and anteroposteriorly narrow. Greatest dorsoventral length is 137.0 mm; greatest mediolaterally width is 88.5 mm; and greatest anteroposterior width is 95.5 mm. MC2 is complete.

In dorsal view, the MC2 is somewhat rectangular. Anterior curvature is concave and the posterior outline is convex. Medial outline is flat and the lateral outline is greatly concave. There are two articular surfaces that have a connective border. Main medial articular surface (ASLM) articulates with the distal articular surface on the lateral side of the magnum (ASMC2). The smaller dorsal articular surface (ASTD2) articulates with the trapezoid's ventral surface (ASMC2(2)). Connective articular margin between the two surfaces is undulatory, with a laterally convex bend posterior to the center. Anteroposterior length of ASTD2 is 89.8 mm and its greatest mediolateral width, which is anteriorly located, is 38.7 mm. Its most narrow in its center with a mediolateral width of 18.4 mm. Anteroposterior length of the ASLM is 76.9 mm and the greatest width is 29.9 mm. ASLM is mostly smooth with a porous medial edge and the ASTD2 is smooth posteriorly and rough with dark staining from its center to the anterior side. Connection between the two surfaces is depressed between them.

In medial view, the MC2 is moderately straight with almost no concave curve. Greatest concavity is seen just below the proximal articular surface (ASMC3(3)), which articulates with the proximal articular surface on the lateral side of the third metacarpal (ASMMC2). There is also a distal articular surface that contours the ventral outline. Other than these articular surfaces, the MC2's medial side is composed of rugose bone with a few large foramina visible. The

concavity wraps around the ventral and posterior outline of the articular surface, and it has several foramina within. This articular surface is a long slender oval that smooth and has a raised center with four osteolytic features clustered anteriorly along the raised distal edge.

Anteroposterior length of the ASMC3(3) is 68.5 mm and its dorsoventral height is 20.3 mm.

Articular rims are flush with the depressed articular surface. Ventral articular surface contours the U-shape and is 72.0 mm in anteroposterior length and 10.1 mm in dorsoventral height. The rest of the bone surface is rugose with no obvious ridges or nodules.

In ventral view, the articular surface for the proximal phalanx of the second digit is the most prominent (AS2PP) feature. Anteroposterior length of the AS2PP is about 59.0 mm and the mediolateral width is greatest at 70.9 mm. Articular surface is very circular and light in color. A darker section of smooth surface cuts mediolaterally across and separates the AS2PP from the articular surfaces of the medial and lateral sesamoids that are posteriorly located from the AS2PP. The dark section is 29.9 mm in anteroposterior length between the AS2PP and sesamoid surfaces. AS2PP has a large raised and light colored circular center with a small osteolytic pathology located at its dorsal border. Anterior articular rim is raised above the AS2PP but the remaining borders are flush with the surface.

In lateral view, there are no separate articular surface but the ASTD2 curve down into the MC2's lateral side with a 50.5 mm anteroposterior length and a 3.9 mm dorsoventral height. Otherwise, the entire lateral side is rugose with various foramina observed. Dorsal edge is mostly flat, whereas the anterior and posterior sides are concave, especially the posterior curvature. Ventral curvature is convex. There is a proximal concave depression that stretches anteroposteriorly beneath the ASTD2, with large foramina.

In anterior view, the bone is entirely rugose. Medial outline is mostly flat but with the slightest concavity; the lateral side is greatly convex starting from the dorsolateral corner, until it reaches a laterally expanded surface of bone near the distal end, and once again curves inwardly towards the ventrolateral corner. Ventral surface is slightly concave and the dorsal outline is flat from the medial edge to the center before flatly slanting down to the dorsolateral corner. Small foramina are scattered about, and larger ones are seen along the medial and lateral margins of the AS2PP's slight anterior curvature. There is a rugose nodule in the dorsomedial corner with soft tissue attachments visible.

In posterior view, there is a large rugose protrusion extending from the dorsolateral corner. Few foramina are visible in the rest of the concave rugose body. Distal medial and lateral sesamoid surfaces are the most prominent features. Medial sesamoid is 48.7 mm in dorsoventral height and its mediolateral width is 23.4 mm. Lateral sesamoid is 46.8 mm in dorsoventral height and its mediolateral width is 31.9 mm. A depression is about 4.0 mm wide. The surfaces are very smooth and flush with their articular borders. A osteolytic pathology is centrally located along the dorsal margin between the two surfaces, and beneath the hole, the bone is very porous. Another osteolytic pathology is located along the ASLS2's lateral rim.

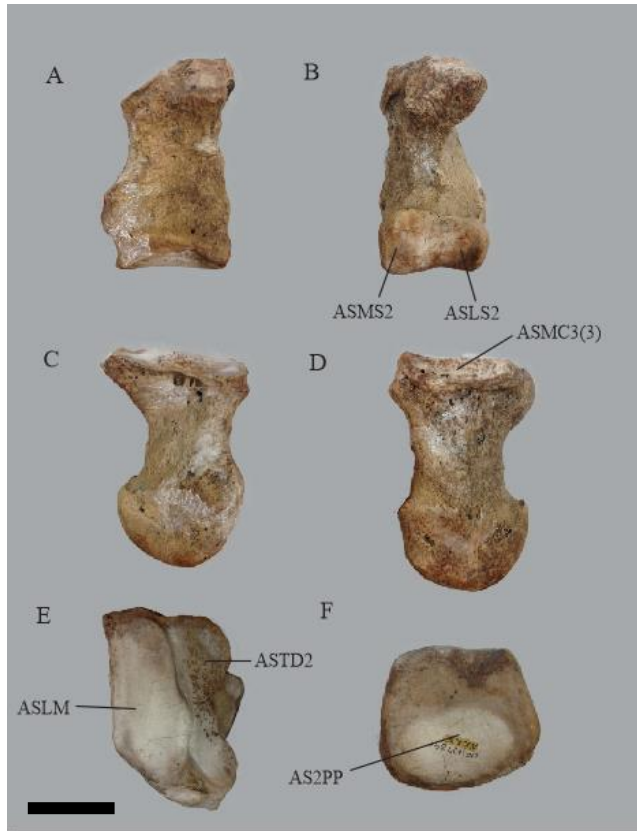


Figure 43: Left Metacarpal II of UF 137891.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASMS2, articular surface for the medial sesamoid of digit II; ASLS2, articular surface for the lateral sesamoid of digit II; ASMC3(3), third articular surface for metacarpal III; ASLM, articular surface for the lateral side of the magnum; ASTD2, second articular surface for the trapezoid; AS2PP, articular surface for the proximal phalanx of digit II. Scale bar = 5 cm.

Metacarpal III. The third metacarpal (MC3) (Figure 44) is the largest metacarpal and it articulates proximally with the magnum, dorsolaterally with the unciform, medially with the second metacarpal, laterally with the fourth metacarpal, and distally with the proximal phalanx for the third digit and two sesamoids. It's dorsoventrally elongate and mediolaterally and anteroposteriorly narrow. Its greatest dorsoventral length is 164.0 mm; its greatest mediolateral width is 88.0 mm; and its greatest anteroposterior width is 99.0 mm. MC3 is complete.

In dorsal view, the shape is very triangular with the anterior edge making the base and the rounded posterior making the point. Two articular surfaces encompass the dorsal surface. The first, and more central, is the articular surface for the magnum (ASM4), which articulates with the magnum's distal surface (ASMC3(2)). Its anteroposteriorly 84.2 mm long, and has a mediolateral width of 36.8 mm. The other dorsal articular surface connects dorsomedially with the unciform (ASUN3), articulating with the distal articular surface on the unciform's medial side (ASMC3). Its anteroposterior length is 81.4 mm and it is mediolaterally 33.3 mm wide. Both surfaces are almost equal in size and both of these articular surfaces share a conjoined border, which forms a laterally convex line from the anterior side to the posterior. Connective margin is the highest point of the MC3 has a large osteolytic pathology in it center. ASUN3 is lighter colored and smoother than the ASMC4's articular surface, which is dark and porous. Medial, lateral, and anterior sides are convexly curved whereas the posterior side comes to a triangular point.

In medial view, the anterior and posterior sides are concave, with the posterior outline more so. Both the dorsal and ventral curvatures are convex. Most of the bone is rugose, but there is a large proximal articular surface (ASMC2(3)), which articulates with the MC2. ASMC2(3) is somewhat rectangular and has an anteroposterior length of 71.4 mm and a dorsoventral height of

29.0 mm. The surface is smooth posteriorly and porous anteriorly, and the articular borders are flush with the surface. There is also a distal articular surface that contours the ventral U-shaped outline, curving up from the ventral side into the medial. It is 77.5 mm in anteroposterior length and 13.0 mm in dorsoventral height. Bone between these two surfaces is dark and rugose with no nodules or ridges. Foramina are located beneath the proximal surface and above the distal surface.

In ventral view, there is a large dark, smooth circle surface between the articular surface for digit III's proximal phalanx and the posteriorly oriented sesamoid surfaces. Its anteroposterior length is 40.3 mm and the mediolateral width between the AS3PP and sesamoid surfaces is 62.9 mm. Greatest anteroposterior length of the AS3PP 66.7 mm, and greatest width is about 79.0 mm. Its raised center has an anteroposterior length of 42.9 mm and a mediolateral width of 64.6 mm. The raised center is light colored and smooth except for a porous middle, which also has a medium sized osteolytic pathology with smooth edges. There are three more tiny osteolytic features located close to the borders. More porousness rims the raised center and three more osteolytic features are located posterior of the raised center.

In lateral view, the anterior and posterior curvatures are concave whereas the dorsal and ventral outlines are convex. Most of the lateral bone is rugose but there is a proximal articular surface, which articulates with the fourth metacarpal (ASMC4(2)). This articular surface is a large oval. It is at least 74.3 mm in anteroposterior length and has a greatest dorsoventral height of 29.0 mm. This surface is smooth with no porous bone or dark stains, and there is a raised ridge along its ventral and posterior border. Articular borders, except the dorsal, are raised above the articular surface. Rugose bone is concave beneath the articular surface with large foramina. There is also a distal articular surface that contours the ventral U-shaped outline, curving up from

the ventral side into the lateral. It is 69.4 mm in anteroposterior length and 11.2 mm in dorsoventral height.

In anterior view, the MC3 has the same shape as the MC2, except that its medial and lateral sides are nearly straight. Many foramina are located along the dorsal and ventral margins. AS3PP curves up into the anterior plane with its convex apex centrally located. The surface is mostly flatly rugose with a small dorsomedial nodule extending outwards.

In posterior view, the MC3 is moderately symmetrical and it gradually narrows proximally. There is a large rugose proximal protrusion, and the MC3 body becomes concave beneath it before extending back out to the sesamoid surfaces. The rugose bone does not have many foramina or soft tissue attachment fibers. Distally, the two sesamoids surfaces have a ridge almost symmetrically between them. ASMS3 is 51.5 mm dorsoventrally long and 31.8 mm mediolaterally wide. ASLS3 is at least 59.4 mm in dorsoventral length and is 28.1 mm mediolaterally wide. The surfaces are light colored and smooth, whereas the ridge is porous and has a small distal osteolytic pathology. Articular borders are flush with the surfaces, which become less smooth towards the rims.

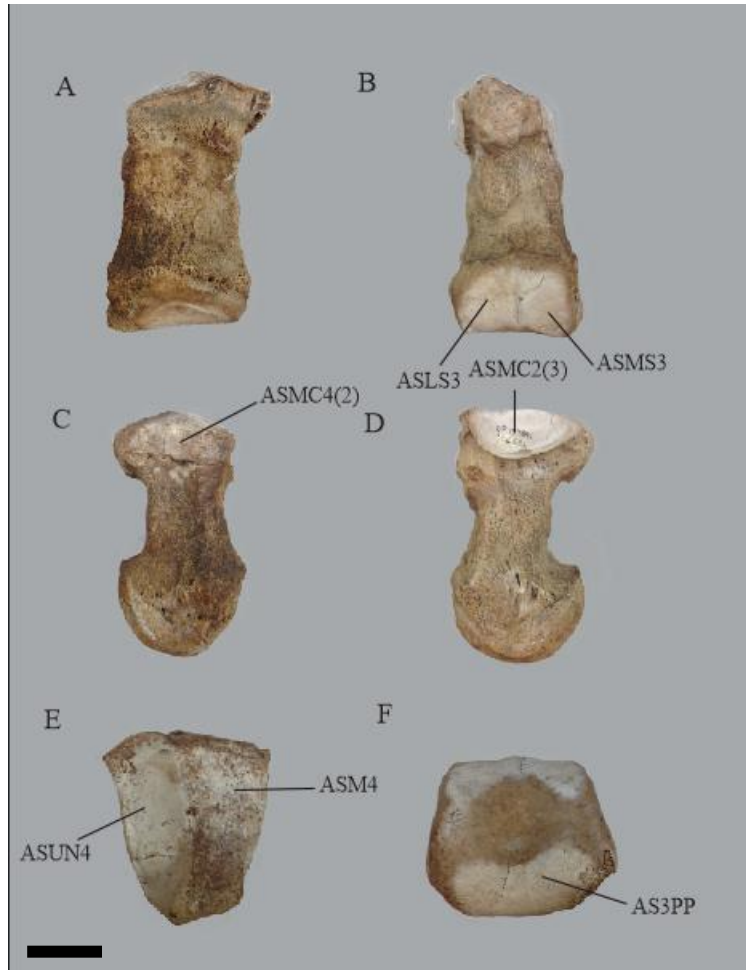


Figure 44: Left Metacarpal III of UF 137891.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASLS3, articular surface of the lateral sesamoid of digit III; ASMS3, articular surface of the medial sesamoid of digit III; ASMC2(3), third articular surface for metacarpal II; ASMC4(2), second articular surface for metacarpal IV; ASUN4, fourth articular surface for the unciform; ASM4, fourth articular surface for the magnum; AS3PP, articular surface for the proximal phalanx of digit III. Scale bar = 5 cm.

Metacarpal IV. The fourth metacarpal (MC4) (Figure 45) articulates proximally with the unciform, dorsomedially with the third metacarpal, laterally with the fifth metacarpal, and distally with the proximal phalanx associated with the fourth digit and two sesamoids. MC4 is dorsoventrally elongate and mediolaterally and anteroposteriorly narrow. Greatest dorsoventral height is 140.0 mm; the greatest mediolateral width is 98.0 mm; and its greatest anteroposterior width is 110.0 mm. MC4 is complete but has several thin cracks on articular surfaces.

In dorsal view, the shape of MC4 is triangular, with the anterior margin forming the base and the posterior end forming the rounded point. The entire dorsal surface is the articular surface that articulates with the distal articular surface of the unciform, or the ASMC4. This surface, ASUN5, is smooth but with dark staining and some porousness along the anterolateral corner and the posterior margin. Its central mediolateral width is 56.7 mm and its greatest anteroposterior length is 85.4 mm. Rugose bone is visible beyond the posterior margin of the ASUN5. Anterior margin is subtly convex with a small central dip. Medial and lateral sides are convex, with the medial outline more so, and the posterior point is convexly narrow and rounded. In dorsal view, the proximal articular surface on the medial side is also visible as it extends outwards medially. This articular surface articulates with the third metacarpal's proximal articular surface on its lateral side (ASMC4(2)). Articular surface (ASMC3(4)) shares an articular border with ASUN5. ASMC3(4)'s proximal articular border is the ASUN5's medial articular border. In dorsal view, the ASMC3(4) gives the MC4 a convex medial outline.

In medial view, the main feature is the proximal articular surface, ASMC3(4). This articular surface has a slightly convex proximal margin, and the rest of the articular border is a large distally convex curvature. MC4's proximal margin is much the same as the ASMC3(4)'s. Posterior outline is deeply concave beneath its proximal extension before broadening back out to

the posterior distal curvature for the sesamoids. Anterior margin is also concave, though not as deeply as the posterior outline. Like the posterior outline, the anterior outline widens back out for the ventral curvature, which is very convex and U-shaped.

Proximal articular surface is smooth with no porousness and the articular border is raised above the articular surface. ASMC3(4) is 66.6 mm in anteroposterior length and 33.5 mm in dorsoventral width. Rest of the bone is rugose and riddled with foramina, the larger ones contouring the articular margin and ventral curvature.

In ventral view, the articular surface for the proximal phalanx for the fourth digit (AS4PP) is most prominent, and the two articular surfaces for the sesamoids are visible posterior to it. Sesamoid surfaces extend into the posterior view whereas the phalanx curve extends into the anterior view. AS4PP has a greatest anteroposterior length of about 70.3 mm and a greatest mediolateral width of about 84.8 mm. The raised surface within the AS4PP has an anteroposterior length of 66.1 mm length towards the medial side and a mediolateral width of 66.1 mm. Greatest mediolateral width in the center of the phalanx and sesamoid articular surfaces is 70.7 mm where there is an oblong depression that sits between the surfaces of the AS4PP and the sesamoids. The raised AS4PP surface is very smooth and larger towards the medial side. There are rubbing striations in the center of the AS4PP and the dorsolateral section is very porous and darkly colored. A small osteolytic pathology is near the center of the raised surface's medial side.

In lateral view, there is one articular surface. Proximal articular surface articulates with the proximal articular surface on the medial side of the fifth metacarpal, ASMC4(3). MC4's proximal articular surface (ASMC5(2)) is a long and thin oval facet. It is smooth with no porousness and its articular border is only raised above the articular surface along the center of

the ventral rim. It has an anteroposterior width of 69.5 mm and a dorsoventral length of 16.8 mm. Rugose bone is slightly concave beneath the articular surface. Very few foramina are visible throughout the rest of the rugose bone, but there is one large one in the center, distally. The only rugose ridge is along the posteroventral curvature, which terminates in the dorsoventral center of the lateral side.

General shape of the MC4 is also similar to the medial side. Dorsal outline is slightly convex whereas the ventral outline is greatly convex, with a very anteroposteriorly wide U-shape. Posterior outline is greatly concave beneath is proximal posterior extension and it expands outwards again with the start of the U-shape distal end. Anterior outline is also deeply concave, and its convexity is also limited to the proximal end as the distal end bulges out with the U contour.

In anterior view, the dorsal outline has a triangular point, which is more medially oriented. Medial outline is moderately straight, and the lateral outline is slightly concave, more so proximally. Ventral outline is subtly concave. Overall, the whole surface is rugose with large foramina following the convex curvature of the anterior portion of the AS4PP. Distal AS4PP curves up into the anterior plane and the articular border stays relatively flush with the articular surface. The only rugose protrusion is a slim one in the anteromedial corner that narrows as it crosses to the lateral side.

In posterior view, the medial and lateral sides are slightly concave proximally before flaring back out distally. Ventral outline is concave with the depression between sesamoid articular surfaces representing the greatest depression. Medial corner extends more distally than the lateral. Most of the posterior bone is rugose and concave beneath the proximal posterior protrusion and above that sesamoid articular surfaces. Sesamoid facets curve into the posterior

side from the ventral edge. Above them, the bone is smooth with rugose soft tissue attachment scars present around the smooth, non-articular, bone. There is a depressed channel on the articular surface between the lateral and medial articular sesamoid surfaces (ASMS4 and ASLS4). Dorsoventral length of the ASMS4 is about 44.4 mm and its mediolateral width is about 33.5 mm. Greatest dorsoventral length of the ASLS5 is 52.1 mm, and its greatest mediolateral width is about 29.4 mm. Both sesamoid articular surfaces are smooth without any porousness.

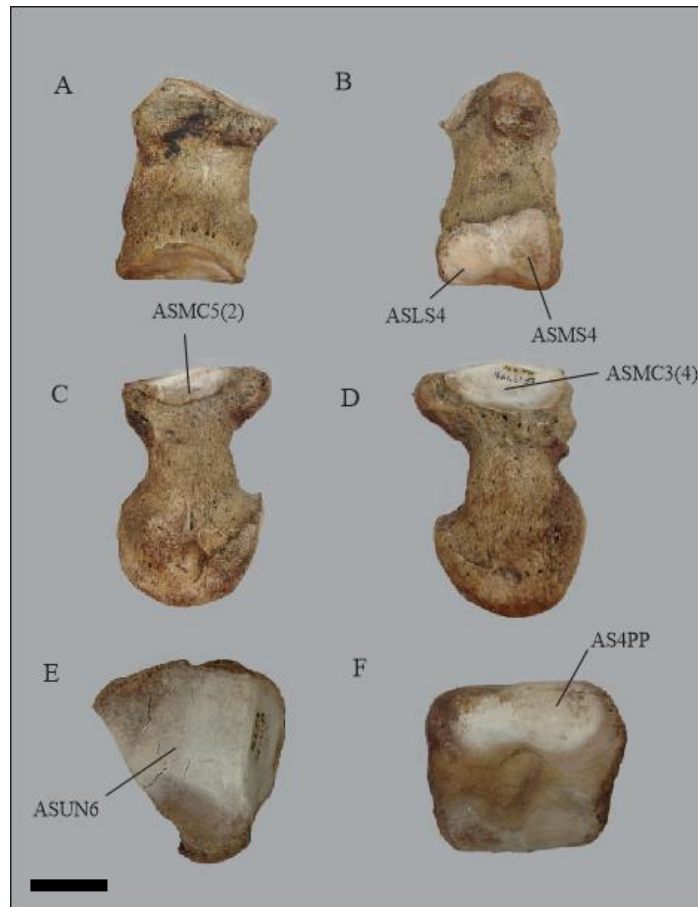


Figure 45: Left Metacarpal IV of UF 137891.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASMS4, articular surface for the medial sesamoid to metacarpal IV; ASLS4, articular surface for the lateral sesamoid to metacarpal IV; ASMC3(4), fourth articular surface to metacarpal III; ASMC5(2), second articular surface to metacarpal V; ASUN6, sixth articular surface for the unciform; AS4PP, articular surface for the proximal phalanx of digit IV. Scale bar = 5 cm.

Metacarpal V. The fifth metacarpal (MC5) (Figure 46) articulates proximally with the unciform, medially with the fourth metacarpal, laterally with the cuneiform, and distally with the proximal phalanx for the fifth digit and two sesamoids. MC5 is dorsoventrally elongate and mediolaterally and anteroposteriorly broad. Its greatest dorsoventral length is 130.0 mm; its greatest anteroposterior width is 94.0 mm; and its greatest mediolateral width is 87.5 mm. MC5 is the most complete metacarpal, having only a few hairline cracks.

In dorsal view, the shape of MC5 is oval. Dorsal surface is comprised of the articular surface for the unciform (ASUN4), which articulates with the unciform's articular surface on its lateral side (ASMC5). ASUN4's greatest anteroposterior length is about 82.2 mm, and its greatest mediolateral width, located centrally, is about 51.4 mm. ASUN4 is very smooth in its center, which is light colored and elevated above the rest of the articular surface. The raised surface has an anteroposterior length of about 68.1 mm, and its greatest mediolateral width is about 33.7 mm. ASUN4's is flush with its articular borders and porous around those rims. Articular surface for the fourth metacarpal (ASMC4(3)), though on the medial side, extends outwards enough that it is visible in dorsal view.

In medial view, the ASMC4(3) is the most notable feature whereas the rest of the bone is rugose with various foramina. ASMC4(3) is rectangular and is long and slender. Articular surface is smooth anteriorly where it is also lighter in color. Greatest anteroposterior length is about 58.8 mm and its greatest dorsoventral height is about 20.7 mm, which tapers to 9.3 mm posteriorly. Dorsal edge is moderately straight whereas the ventral outline forms a convex U-shaped curvature. Both the posterior and anterior outlines are concave. Other than the ASMC4(3), the bone is rugose, especially along the medially oriented posterior protrusion. Ventral rugose bone is has become smooth along the ventral curvature and a smooth band

extends from its center to the center of the anterior side. Large foramina border the smooth rugose surface.

In ventral view, the articular surface for the proximal phalanx for the fifth digit (AS5PP) is most prominent, and the two articular surfaces for the sesamoids are visible posterior to it. Sesamoid surfaces extend into the posterior view whereas the phalange curve extends into the anterior view. AS5PP has a greatest anteroposterior length of about 69.3 mm and a greatest mediolateral width of about 67.2 mm. AS5PP has a raised, lighter center, with an anteroposterior length of about 47.2 mm and a greatest mediolateral width of about 47.6 mm. Besides the anterior rim, the articular borders are flush with the surface and little porosity was observed. Between the AS5PP and the sesamoid surfaces, there is a dark band of smooth bone, about 32.5 mm wide, that is very porous.

In lateral view, there is a small articular surface for the cuneiform, or ASC3. This articulates particularly with the cuneiform's ventral section of its lateral projection. ASC3 is about 47.3 mm anteroposteriorly long and has a greatest dorsoventral height of 18.9 mm. The surface is very porous posteriorly but is otherwise smooth and flush with its articular borders. Anterior and posterior sides are concave. Ventral contour is convex, and the dorsal outline is moderately straight and slanting from the anterior side down to the posterior. Beneath the proximal articular surface is a large rugose ridge that extends from the proximal anterior corner down to the center of the posterior side's concave outline. Foramina are visible throughout the rugose bone and along the ventral margin.

In anterior view, the medial and lateral sides are slightly concave whereas the ventral contour is convex and the dorsal contour is mostly concave. The entire surface is rugose except for the small distal section where the AS5PP curves up slightly into the anterior plane. The most

notable rugose feature is a large soft tissue attachment scar that runs mediolaterally in the center of the anterior side. Soft tissue attachment fibers run mediolaterally and connect to a small proximal nodule on the lateral side. Large foramina are within the scar band.

In posterior view, the medial and lateral sides are slightly concave and the dorsal outline is convex. Ventral outline is slightly concave. Most of the posterior bone is rugose and there is a mediolateral concavity in the center. There is a small depression between the lateral and medial articular sesamoid surfaces (ASMS5 and ASLS5). Greatest dorsoventral length of the ASMS5 is about 37.1 mm and its mediolateral width is about 30.8 mm. Greatest dorsoventral length of the ASLS5 is 36.3 mm, and its greatest mediolateral width is about 39.5 mm. Both surfaces are entirely smooth and flush with their articular borders, and a few large foramina are above the borders. Distal section of the separating cleft has a small osteolytic pathology with smooth edges. Proximally, there is a large rugose section of attachment scarring for soft tissue, which is also riddled with large foramina. Fibers run mediolaterally and curve upwards and a central, proximal apex.

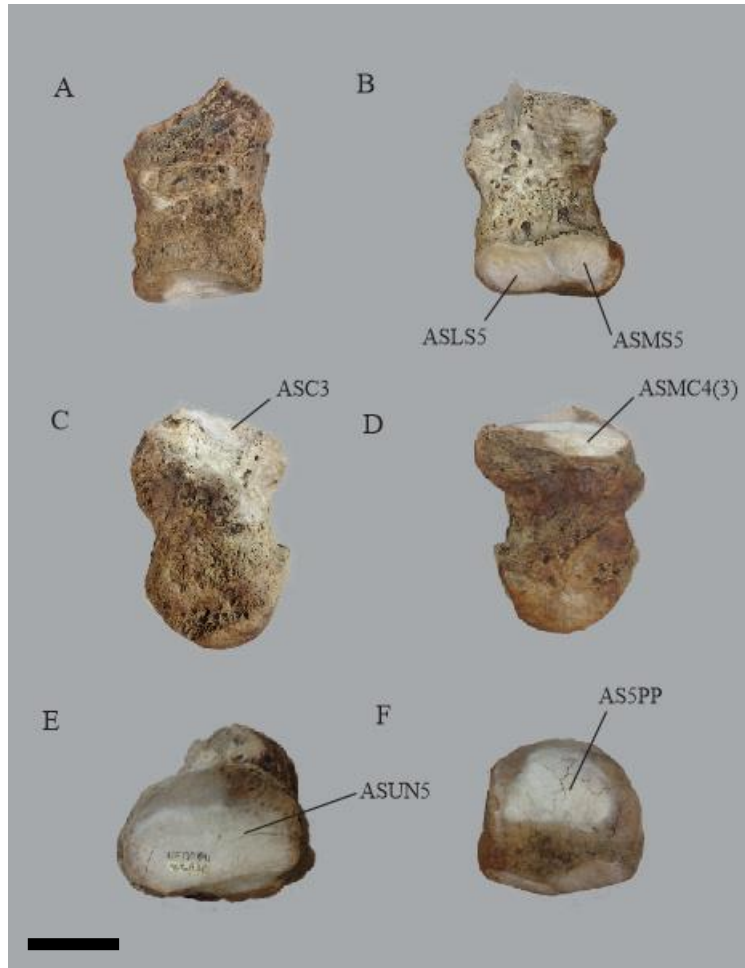


Figure 46: Left Metacarpal V of UF 137891.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASLS5, articular surface for the lateral sesamoid of digit V; ASMS5, articular surface for the medial sesamoid of digit V; ASC3, third articular surface for the cuneiform; ASMC4(3), third articular surface for metacarpal IV; ASUN5, fifth articular surface for the unciform; AS5PP, articular surface for the proximal phalanx of digit V. Scale bar = 5 cm.

Phalanges

Proximal Phalanges

Proximal Phalanx Digit II. The proximal phalanx for digit II (PP2) (Figure 47) articulates proximally with the distal surface of Metacarpal II and distally with the proximal surface of the medial phalanx for digit II. It is dorsoventrally elongate and mediolaterally and anteroposteriorly narrow. Its greatest dorsoventral length is 87.0 mm; its greatest mediolateral width is 81.0 mm; and its greatest anteroposterior width is 61.0 mm. PP2 is complete but with some thin cracks on articular surface.

In dorsal view, the oval articular facet that articulates with the distal articular surface of the second metacarpal is the prominent feature (ASDMC2). ASDMC2 is about 70.8mm in greatest mediolateral width and 50.7 mm in greatest anteroposterior length. Shape of the facet is more tear dropped, with the lateral side comprising the point, with rugose bone extending beyond the articular surface. The articulation itself is concave with the posterior side extending more proximally than the anterior section. The surface is smooth, with porous edging and a darker, depressed lateral section. The surface is flush with its articular borders.

In medial view, the posterior, anterior, and dorsal outlines of the bone are all inwardly concave whereas the ventral outline is convexly U-shaped. Posterior curvature is also more pronounced than the anterior's. Medial side is quite straight compared to its greatly curved lateral counterpart, but there is a concave channel in the center between the extended proximal circumference ridge and distal surface. Two small nodules of rugose bone are in the central concavity. Dorsal section has the parallel fibers, and small foramina are scattered about, especially along the dorsal and ventral margins.

In ventral view, the oval articular surface that articulates with the proximal articular surface for the medial phalanx of digit II (ASPMP2) is the prominent feature and mimics the ASDMC2 facet in shape in that the lateral side is narrower than the medial. Ventral facet is about 60.6 mm in greatest mediolateral width and has an anteroposterior length of about 31.6 mm. There is a raised center that has a mediolateral width of 45.3mm and an anteroposterior length of 29.2 mm. The entire surface is smooth and flush with its articular borders.

In lateral view, the anterior and posterior outlines are concave. Dorsal outline is flatly diagonal with the posterior edge more elevated than the anterior, and the ventral outline is convexly U-shaped. Lateral side is greatly curved with an undulating surface that is proximally extended and inwardly runs to the lateral U-shape rim. The entire lateral section is rugose, comprised of fibrous intercrossed, parallel, and webby textures and no foramina are visible. There is a large rugose protrusion proximally and posteriorly oriented on the medial side.

In anterior view, the PP2 is rugose. There is an extended rugose ridge proximally located that is running around the circumference of the PP2. Beneath this ridge, the anterior side becomes distally concave. Dorsal outline is convex, along with the lateral outline. Medial outline is concave, and the ventral outline is mostly straight. ASPMP2 does not truly curve into the anterior side. Large foramina follow along the dorsal and ventral margins. There are also two small rugose nodules on the lateral side, one proximal and one distal.

In posterior view, the most notable features are the proximal attachment scarring and the distal surface for cartilage. The rugose circumference ridge is large and has several soft tissue fibers running dorsoventrally across the ridge. Foramina are above the ridge, and one large foramen sits in a central circular depression along the proximal margin. Near the center of the medial side, there is a rugose groove for attachment. Distally, a smooth ventral surface runs

mediolaterally and has a greater dorsoventral height near the medial edge. Dorsal outline is convex with the medial outline being concave. Lateral side is undulating with its convexity proximally oriented, and the ventral margin is moderately straight with the medial corner extending more distally than the lateral corner.

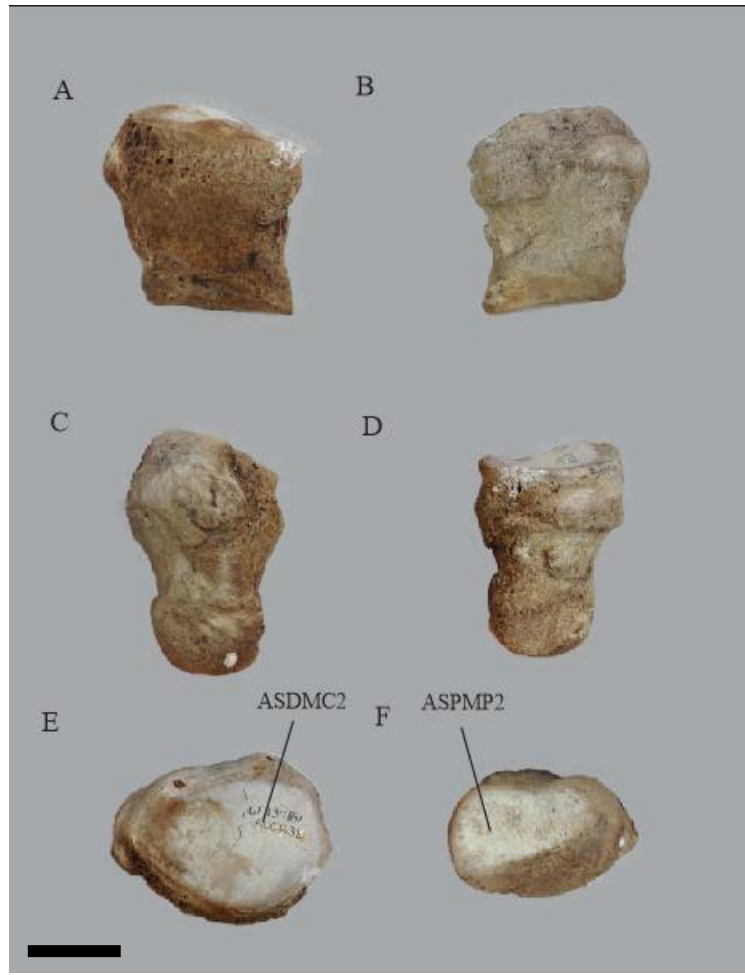


Figure 47: Left proximal phalanx of digit II of UF 137891. A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASPMP2, articular surface to the proximal surface of the medial phalanx of digit II; ASDMC2, articular surface to the distal surface of metacarpal II. Scale bar = 5 cm.

Proximal Phalanx Digit III. The proximal phalanx for digit III (PP3) (Figure 48) articulates proximally with the distal surface of Metacarpal III and distally with the proximal surface of the medial phalanx for digit III. It is dorsoventrally elongate and mediolaterally and anteroposteriorly narrow. Its greatest dorsoventral length is 92.5 mm; its mediolateral width is 85.0 mm; and its greatest anteroposterior width is 63.5 mm. PP3 is complete with some thin cracks on articular surfaces.

In dorsal view, the entire surface is comprised of the articular surface that articulates with the distal articular surface of the third metacarpal (ASDMC3). This slightly concave articular surface is about 74.6 mm in mediolateral width and 51.3 mm in greatest anteroposterior length. Overall shape is symmetrically heart shaped. Center of the posterior margin dips inwards and the anterior margin forms a rounded central point, with the medial and lateral sides convexly curve to. Articular surface is smooth, and light colored in the center and darkens and becomes slightly porous along the articular rims. Articular borders are flush with the articular surface.

In medial view, the rugose bone and has no obvious foramina. Posterior curvature is deeply concave whereas the anterior outline is slightly concave. Ventral outline has the typical U-shape convex curvature and the dorsal outline is moderately flat. Medial side itself has a central concave channel but the distal U-shaped extension of bone and the proximal rugose ridge that runs anteroposteriorly. The distal extension has more fibrous soft tissue attachments.

In ventral view, the articular surface that articulates with the proximal articular surface on the medial phalanx for the digit III is the prominent feature (ASPMP3). This surface is an oblong, symmetrical oval. It is about 71.9 mm in mediolateral width and is 35.5 mm in anteroposterior length. It has a lighter raised center with a mediolateral width of 56.6 mm and an anteroposterior length of 29.6 mm. The entire ASPMP3 is smooth, even at the darker rims.

Centrally posterior to the raised articular surface is a depression with three small osteolytic features clustered together.

In lateral view, the rugose bone symmetrically mirrors the bone's medial side. The outlines, proximal and distal extensions, central channel, and soft tissue attachments are all similar. Soft tissue attachment fibers are visible on the proximal rugose ridge and at the distal rugose extensions. For each, the fibers run anteroposteriorly.

In anterior view, the PP3 is rugose and very symmetrical. Both the medial and lateral outlines display wide central channels running between proximal and distal extensions in the bone. The dorsal outline is convex and the ventral outline is subtly concave, almost straight. The anterior side itself is almost straight with only a small concave curvature beneath the circumference ridge. ASPMP3 curves into the anterior side with an upwardly convex curvature, framed by some small foramina, which also occurs along proximally, above the ridge.

In posterior view, the two most notable features are the cartilaginous surface and the proximal rugose ridge. The distal smooth surface has distinct medial and lateral divisions, separated by a central cleft. Above each cartilaginous condyle is a deep groove in the central rugose body. Each groove has a large foramen at its depressional apex. Proximally, the rugose ridge is wide and has little foramina but several dorsoventrally oriented soft tissue attachment fibers. Above the proximal ridge and centrally located, there is a concave dip in the bone.

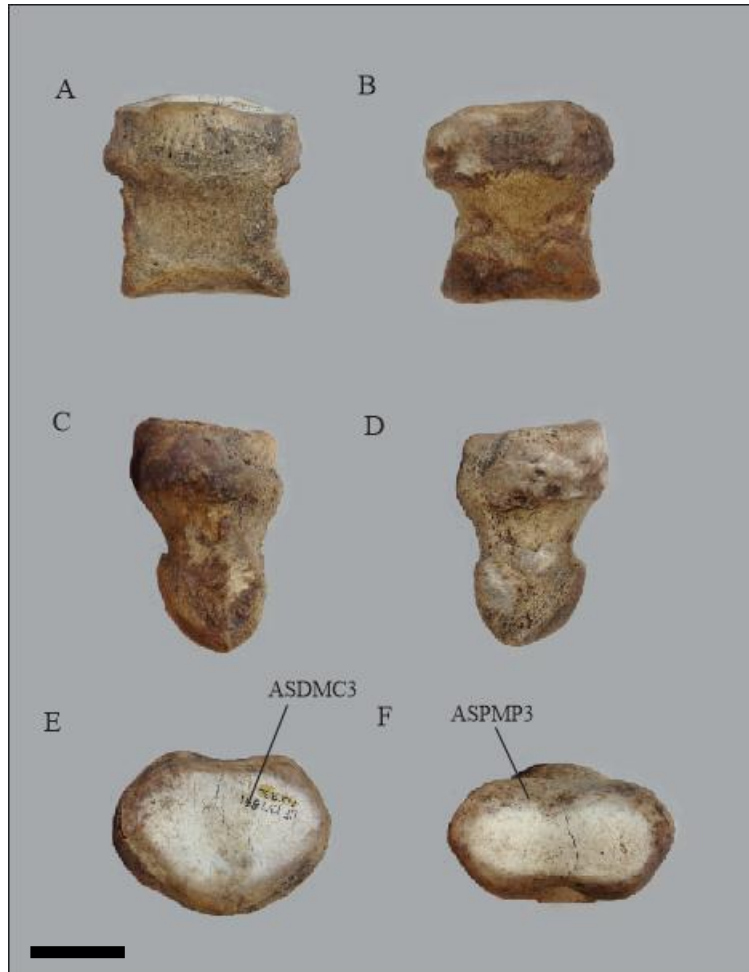


Figure 48: Left proximal phalanx of digit III of UF 137891. A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASPMP3, articular surface to the proximal surface of the medial phalanx of digit III; ASDMC3, articular surface to the distal surface of metacarpal III. Scale bar = 5 cm.

Proximal Phalanx Digit IV. The proximal phalanx for digit IV articulates proximally with the distal surface of Metacarpal IV and distally with the proximal surface of the medial phalanx for digit IV. It is dorsoventrally and mediolaterally elongate and anteroposteriorly narrow. Its greatest dorsoventral length is 95.0 mm; its greatest mediolateral width is 85.0 mm; and its greatest anteroposterior width is 65.0 mm. PP4 is complete with only a few thin cracks in the articular surfaces.

In dorsal view, the articular surface that articulates with the distal articular surface on the metacarpal IV (ASDMC4) takes up the entire dorsal view. ASDMC4 is circular and has an anteroposterior length of about 55.1 mm and mediolateral width of about 73.5 mm. Overall shape is symmetrically heart shaped. Center of the posterior margin dips inwards and the anterior margin forms a rounded central point, with the medial and lateral sides convexly curve to; however, there is an indentation of the articular surface on the medial side that slight deforms the heart-shape. The surface is mostly light colored and smooth with little porousness along the edges, but there are four osteolytic features. The first osteolytic pathology is large and in the posterolateral corner. The next pathology is near the center and is small. Anteriorly, there are two osteolytic features that have extended towards the center, making them appear like grooves instead of holes. In all cases, the edges are smooth.

In medial view, the bone is rugose. Posterior outline is greatly concave whereas the anterior outline is only slightly so, being more straight than curved. Dorsal outline is also concave, and the ventral outline is convexly U-shaped. The proximal area has a subtle mediolateral ridge for soft tissue attachment, along with some small foramina. Below the ridge, the bone becomes slightly concave before extending back out with the distal rugose surface. There is also a triangular, extended scarring section anteriorly.

In ventral view, the articular surface that articulates with the proximal articular surface of the medial phalanx for digit IV (ASPMP4) is very oblong, oval, and smooth. Its greatest mediolateral width is 65.1 mm and its maximal anteroposterior length is 40.1 mm. Articular surface also has a raised center that is 31.4 mm in anteroposterior length and 55.1 mm in mediolateral width. ASPMP4 is very smooth with a posterior dip beyond the center of its raised surface. Two large osteolytic features are noted, one medially oriented in the raised surface and one laterally oriented, close to the rim. There are also about ten other pin-prick sized osteolytic features scattered about, most along the edge of the raised central surface.

In lateral view, the rugose bone is similar in shape to the medial side. Main difference is that there is no concave channel. Instead, a rugose nodule starts at the posterodorsal end and extends down and inward towards the bone's center. This rugose ridge is much more pronounced than the one on the medial side. There are also small foramina along the anterodorsal margin.

In anterior view, PP4 is very square. The rugose bone has the proximal circumference ridge, which does not connect with the medial and lateral proximal ridges. Medial outline is moderately straight with a little central indentation. Lateral side is convex, and the dorsal outline is convex. Ventral outline is slightly concave with the medial corner more distally extended than the lateral corner. Dorsal outline is moderately flat as is the ventral margin; however, the medial corner of the ventral outline is slightly more distally extended than the lateral side. Part of the ASPMP4 curves up into the anterior view and is convexly curved. Above the articular rim, the anterior side's rugose bone depressed from the border and has large foramina near the lateral side. Near the center of the ASPMP4's anterior margin, a rugose pocket breaks the smooth curvature.

In posterior view, the rugose PP4 has a very pronounced proximal circumference ridge, which does connect with the proximal ridge on the medial and lateral sides. The bone is deeply concave below the ridge before extending back out at the smooth distal cartilage surface. The distal smooth surface has distinct medial and lateral divisions, separated by a subtle central cleft. Above each cartilaginous condyle is a deep groove in the central rugose body. There are no foramina in the grooves and the lateral groove is much more pronounced than the subtle medial groove.

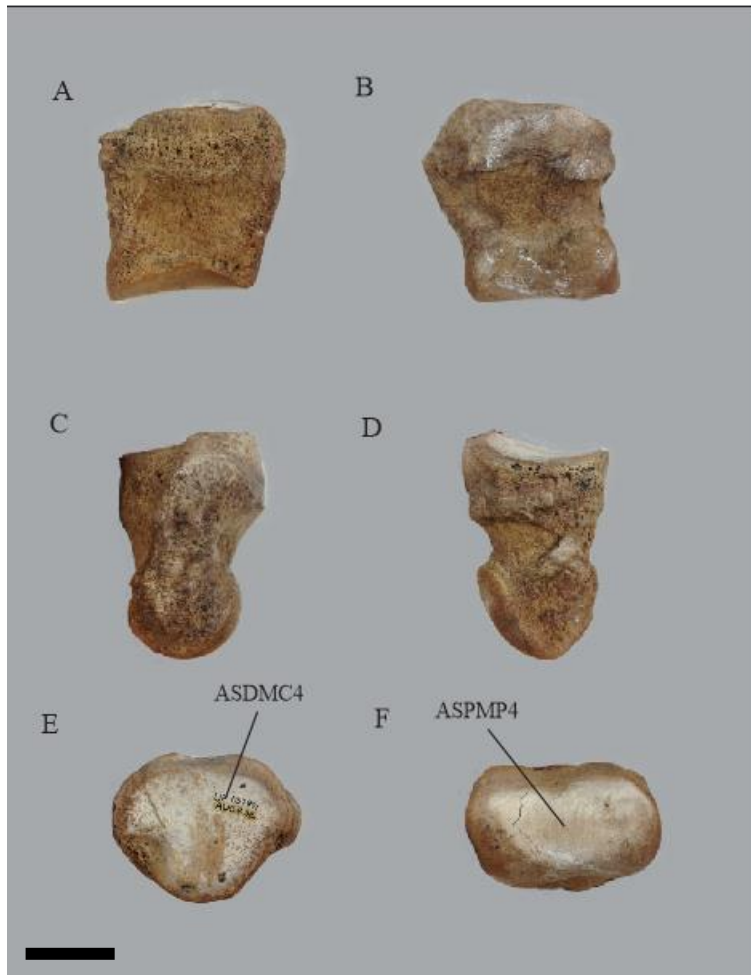


Figure 49: Left proximal phalanx of digit IV of UF 137891. A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASPMP4, articular surface to the proximal surface of the medial phalanx of digit IV; ASDMC4, articular surface to the distal surface of metacarpal IV. Scale bar = 5 cm.

Proximal Phalanx Digit V. The proximal phalanx for digit V (PP5) (Figure 50) articulates proximally with the distal surface of Metacarpal V and distally with the proximal surface of the medial phalanx for digit V. It is dorsoventrally elongate and mediolaterally and anteroposteriorly narrow. Its greatest dorsoventral length is 96.0 mm; its mediolateral width is 73.0 mm; and its anteroposterior width is 61.0 mm. PP5 is complete with only a few thin cracks on the articular surfaces.

In dorsal view, the circular articular surface that articulates with the distal articular surface of metacarpal V (ASDMC5) is smooth with numerous small osteolytic features clustered along the center of the lateral edge. Mediolateral width of the ASDMC5 is about 56.9 mm and its anteroposterior length is 58.6 mm. Articular surface is flush with the articular borders.

In medial view, the ASDMC5 is visible with the posterior margin making its highest point as it concavely curves down to the anterior margin. Ventral margin is convexly U-shaped. Both the anterior and posterior sides are concave beneath a large proximal extension of bone encircling the PP5 and above an extended distal surface. Proximal rugose ridge has small foramina and soft tissue attachment fibers, and the entire surface of the PP5's medial side is rugose.

In ventral view, the articular surface that articulates with the proximal articular surface on the medial phalanx for digit V (ASPMP5) is pear shaped, with the lateral end being the narrower surface area. It has a greatest mediolateral width of 45.9 mm and a greatest anteroposterior length of 33.3 mm. Its raised surface has a mediolateral width of 41.3 mm and an anteroposterior length of 26.1 mm. Overall surface is slightly porous, and the posterior area has a dark circular impression. This circular impression is distally located from the pitted oval on the posterior side

by only a few millimeters. ASPMP5's anterior section, which curves into the anterior side, also has a circular pitted area.

In lateral view, the anterior and posterior outlines are concave, with the anterior side having the greater inwards curvature. Dorsal outline is concave and the ventral outline is convexly U-shaped. There is a large proximal posterior protrusion that extends outwards with a small concave channel beneath it. Very few foramina are visible.

In anterior view, the PP5 is entirely rugose. The center is slightly concave beneath an extended proximal and distal rugose surface. More foramina are dorsally located along the margin. Distally, the depressed circular pit of the ASPMP5 curves into the anterior side and is roughly textured.

In posterior view, the dorsal outline is convex, and the ventral outline is concave, but both have more distally extended medial sides. Medial and lateral outlines are slightly concave. The center of the bone is slightly concave with a few large foramina on the medial side. The distal smooth cartilage surface has an oval, pitted area covering much of the lateral cartilage surface. Proximally, above the thick rugose ridge, is a circular depression, seen in the other proximal phalanges.

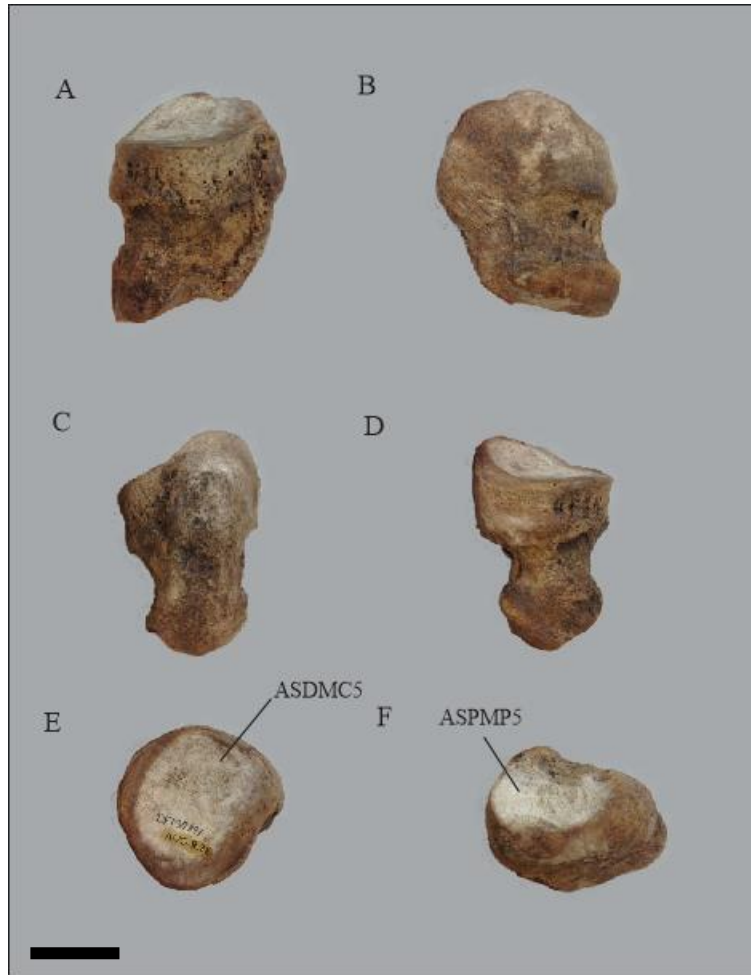


Figure 50: Left proximal phalanx of digit V of UF 137891. A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASPMP5, articular surface to the proximal surface of the medial phalanx of digit V; ASDMC5, articular surface to the distal surface of metacarpal V. Scale bar = 5 cm.

Medial Phalanges

Medial Phalanx Digit II. The medial phalanx for digit II (MP2) (Figure 51) articulates proximally with the distal surface of PP2 and distally with the proximal surface of the terminal phalanx for digit II. It is mediolaterally elongate and dorsoventrally and anteroposteriorly narrow. Its greatest dorsoventral length is 49.0 mm; its mediolateral width is 57.5 mm; and its anteroposterior width is 37.0 mm. MP2 is complete.

In dorsal view, the articular surface that articulates with the distal articular surface of the proximal phalanx for digit II (ASDPP2) is the main feature. ASDPP2 is very oval shaped and concave, with the posterior side more elevated than the anterior. It is about 49.1 mm in mediolateral width and 32.7 mm in anteroposterior length. The surface is centrally smooth and porous along the edges. Articular borders are mostly flush with the articular surface.

In medial view, the bone is entirely rugose. Dorsal outline is flat and diagonal, going from the posterior side down to the anterior. Anterior and posterior outlines are slight concave, almost equally. Ventral outline is convexly rounded. There is a rugose ridge in the anteroposterior center and small foramina are proximally and distally located.

In ventral view, the articular surface that articulates with the posterior articular surface for the terminal phalanx of digit II (ASTP2) is oval shaped. Mediolateral width is 40.3 mm and the anteroposterior length is 18.7 mm. The surface is lightly pitted anteriorly and smooth posteriorly.

In lateral view, the bone is entirely rugose. Dorsal outline is concave, along with the posterior and anterior outline, and the ventral outline is still roundly convex. A small ridge

extends from the proximal posterior corner and extends down to the center of the anterior edge. Small foramina are riddled throughout the lateral surface.

In anterior view, the dorsal outline is convex. Ventral margin is slightly concave, as is the medial appears mostly straight and the lateral outline is strongly convex proximally. The entire surface is rugose, with many small foramina located beneath the dorsal rim. A rugose ridge cuts across the mediolateral width, leaving elongated concave pits above and below it.

In posterior view, the dorsal outline is concave; the ventral outline is flat, the medial outline is vaguely concave; and the lateral outline is convex, especially proximally. Most of the rugose surface is smooth, with the smooth cartilage surface almost blending in with the central concave surface. Laterally, there is a dark circle over both the cartilage surface and the rugose surface. Foramina are not noted.

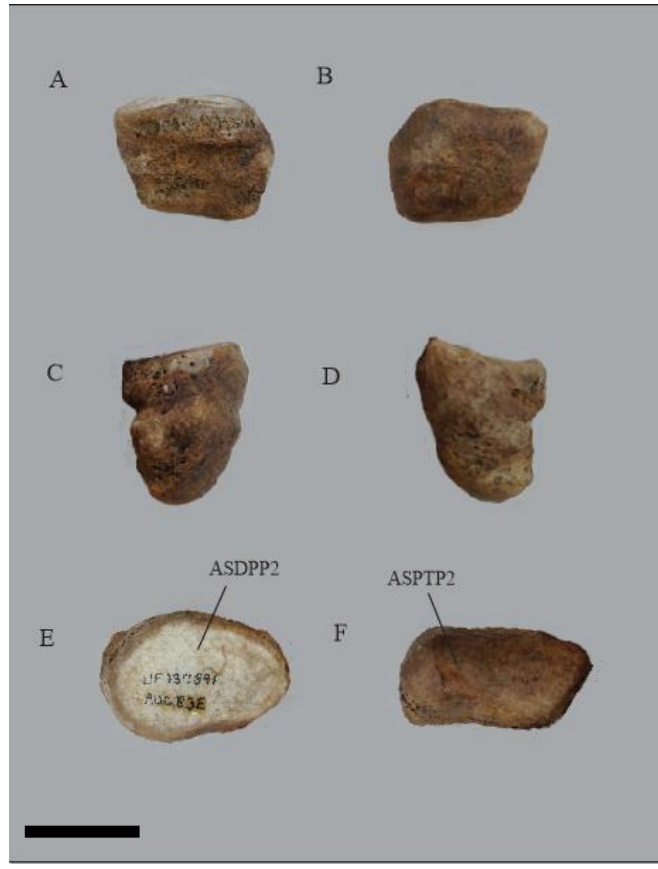


Figure 51: Left medial phalanx of digit II of UF 137891.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASPTP2, articular surface to the posterior surface of the terminal phalanx of digit II; ASDPP2, articular surface to the distal surface of the proximal phalanx of digit II. Scale bar = 5 cm.

Medial Phalanx Digit III. The symmetrical medial phalanx for digit III (MP3) (Figure 52) articulates proximally with the distal surface of PP3 and distally with the proximal surface of the terminal phalanx for digit III. It is mediolaterally elongate and dorsoventrally and anteroposteriorly narrow. Its greatest dorsoventral length is 52.5 mm; its mediolateral width is 66.0 mm; and its anteroposterior width is 38.0 mm. MP3 is mostly complete but has some severe chipping and cortical weathering.

In dorsal view, the symmetrical articular surface that articulates with the distal articular surface of the proximal phalanx for digit III (ASDPP3) is the main feature. ASDPP3 is very oval shaped and slightly concave, with the posterior side more elevated than the anterior. It is about 59.3 mm in mediolateral width and 29.0 mm in anteroposterior length. Its raised surface is 51.3 mm in mediolateral width and the anteroposterior length remains the same. The surface is porous and has three large osteolytic features along the posterior margin. Posterior and anterior articular border is raised above the surface but the medial and lateral articular surfaces are flush with the articular border. Anterolateral edge appears to have arthritic dimpling.

In medial view, the bone is entirely rugose. Dorsal, anterior, and posterior outlines are concave whereas the ventral outline is convex. Ventral outline is convexly rounded, but not quite U-shaped. There is a rugose ridge that runs from the proximal posterior margin across and down to the anterior central margin. There is also a rugose ridge running from the distal posterior side and convexly curves to the middle of the ventral margin. Posterior to the ridge, the bone is concave.

In ventral view, the articular surface that articulates with the posterior articular surface for the terminal phalanx of digit III (ASPTP3) is probably oval shaped but indeterminate from

chipping and weathering; however, deep holes are present in the worn surface and it appears irregular, or arthritic.

In lateral view, the bone is rugose. Dorsal edge is moderately flat and the anterior and posterior outlines are subtly concave whereas the ventral margin is convexly rounded. There is a small rugose nodule proximally and posteriorly located.

In anterior view, the MP3 is very symmetrical. Dorsal, medial, and lateral outlines are convex and the ventral outline is concave. There is an elongated concave pit in the center of the anterior surface. Medial side has irregular nodules, like arthritic growths.

In posterior view, the MP3 is very symmetrical and the dorsal outline is convex; the ventral outline is greatly concave; and the medial and lateral sides are convex. The entire surface is rugose but the distal end has too much wear and chipping to view any cartilage surface. There are two central pockets close to the distal wearing and there is grooved dimpling along the dorsal border. Foramina are absent.

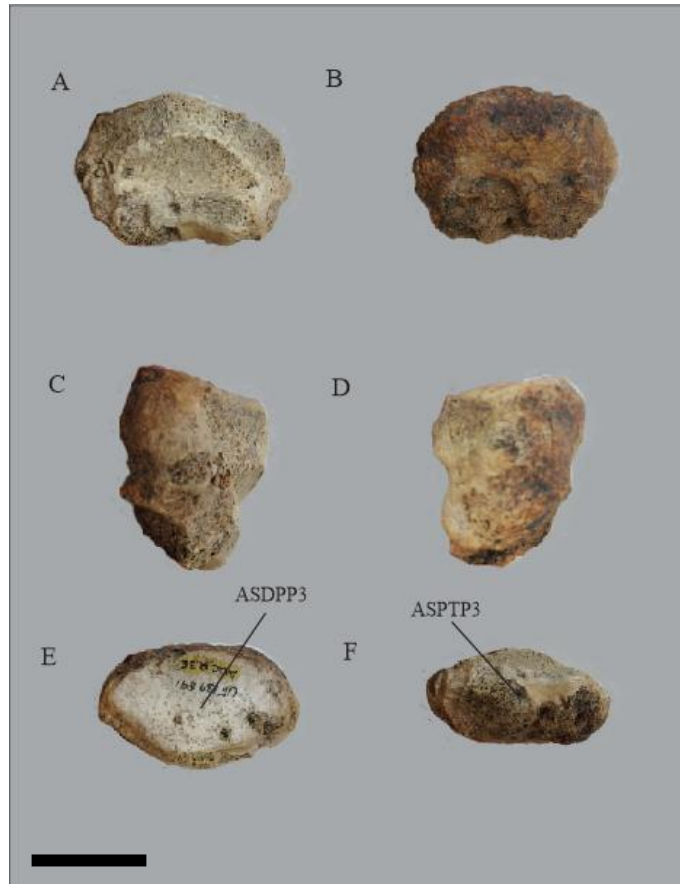


Figure 52: Left medial phalanx of digit III of UF 137891.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASPTP3, articular surface to the posterior surface of the terminal phalanx of digit III; ASDPP3, articular surface to the distal surface of the proximal phalanx of digit III. Scale bar = 5 cm.

Medial Phalanx Digit IV. The medial phalanx for digit IV (MP4) (Figure 53) articulates proximally with the distal surface of PP4 and distally with the proximal surface of the terminal phalanx for digit IV. It is mediolaterally elongate and dorsoventrally and anteroposteriorly narrow. Its dorsoventral length is 51.0 mm; its mediolateral width is 67.0 mm; and its greatest anteroposterior width is 37.0 mm. MP4 is complete.

In dorsal view, the articular surface that articulates with the distal articular surface of the proximal phalanx for digit IV (ASDPP4) is the main feature. ASDPP4 is oval and flat. It is about 58.7 mm in mediolateral width and 32.3 mm in anteroposterior length. The surface is very smooth with a small osteolytic pathology on the medial side. Only the anterior and posterior borders are raised above the articular surface whereas the medial and lateral sides are flush with it.

In medial view, the bone is entirely rugose. Dorsal outline is flat and posterior and anterior outlines are concave. Ventral outline is convex. There is a rugose ridge that runs from the proximal posterior margin across and down to the anterior central margin. No foramina are noted.

In ventral view, the articular surface that articulates with the posterior articular surface for the terminal phalanx of digit IV (ASTP4) is oval and separated into a medial and lateral condyle. Mediolateral width of the ASTP4 is about 44.1 mm. Central anteroposterior length is 11.5 mm. The surfaces are smooth.

In lateral view, the bone is entirely rugose. Dorsal outline is flat and posterior and anterior outlines are concave. Ventral outline is convex. There is a rugose ridge that runs from

the proximal posterior margin across and down to the anterior central margin. Small foramina are distally oriented.

In anterior view, the dorsal, medial, and lateral outlines are convex whereas the ventral margin is concave. The entire surface is rugose and there is a central elongated and concave pit beneath a proximal ridge. Distally, on both the medial and lateral sides, there are small rugose nodules that stretch towards the center and are beneath the pit. No foramina are noted.

In posterior view, the dorsal outline is diagonal, extending from the lateral side and down to the medial; the ventral outline is concave, and the medial and lateral sides are convex. A small section of cartilaginous surface is distally located and spans the entire mediolateral width. This surface is convexly curved towards the proximal end of the MP4. It is very smooth with no apparent central cleft. Above the cartilaginous surface, the bone is concave and rugose. Rugosity lessens towards the dorsal margin, where it becomes smoother. Foramina are absent.

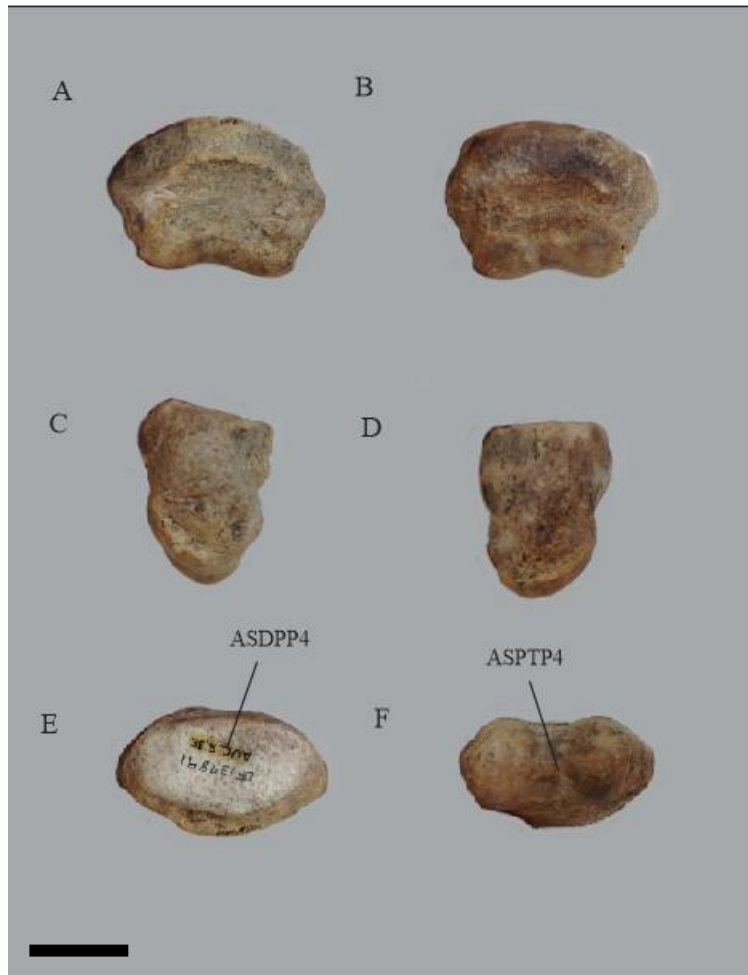


Figure 53: Left medial phalanx of digit IV of UF 137891. A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASPTP4, articular surface to the posterior surface of the terminal phalanx of digit IV; ASDPP4, articular surface to the distal surface of the proximal phalanx of digit IV. Scale bar = 5 cm.

Medial Phalanx Digit V. The medial phalanx for digit V (MP5) (Figure 54) articulates proximally with the distal surface of PP5 and distally with the proximal surface of the terminal phalanx for digit V. It is dorsoventrally elongate and mediolaterally and anteroposteriorly narrow. Its dorsoventral length is 61.0 mm; its mediolateral width is 63.0 mm; and its greatest anteroposterior width is 38.5 mm. MP5 is entirely complete.

In dorsal view, the articular surface that articulates with the distal articular surface of the proximal phalanx for digit V (ASDPP5) is the main feature. ASDPP5 is oval and is concave, with the posterior side more elevated than the anterior. It is about 55.8 mm in mediolateral width and 36.2 mm in anteroposterior length. Articular surface is very smooth with little porousness. Only the posterior articular border is elevated above the articular surface, the rest is flush with it.

In medial view, the bone is entirely rugose. Dorsal and posterior outlines are concave and the ventral outline is convex. Anterior outline is concave proximally with an convexly extended rugose ridge in the center. Below the ridge, the surface is relatively flat. The rugose ridge is on the anterior side but wraps around to the medial side. Many small foramina are clustered around the ridge.

In ventral view, the articular surface that articulates with the posterior articular surface for the terminal phalanx of digit V (ASTP5) is bow shaped, with almost separate medial and lateral condyles. Greatest mediolateral width of the ASTP5 is about 41.4 mm, and the greatest anteroposterior length is 20.0 mm. A central depression nearly separates the surface into medial and lateral sides, and this cleft is almost perfectly centered. ASTP5 is very smooth and dark in its center and its articular borders remain flush with it.

In lateral view, the dorsal outline is deeply concave. Posterior outline is convex whereas the anterior outline is concave. Ventral outline is roundly convex. Medial side is wider than the lateral and it extends more distally; because of this, the medial side is visible framing the smaller lateral side. Lateral side is rugose, with some small foramina scattered about and some soft tissue attachment fibers are visible. There are no protrusions, ridges, or nodules.

In anterior view, the dorsal outline is shaped by the elevated posterior margin to the ASDPP5, which is convex. Ventral margin is deeply concave with the greatest depression more laterally located. Medial and lateral outlines are convex, with the medial side more convex in the center and the lateral side more concave distally. The entire surface is rugose, with many small foramina located beneath the dorsal rim. There is a mediolaterally elongated and depressed trench or pit close to the medial side and it does not extend to the lateral side, which is smoothly rugose with a large foramen in its proximal region.

In posterior view, overall shape of the MP5 matches its description of its anterior side. Dorsal outline is convex; the ventral outline is concave with its greatest depression more laterally located; the medial and lateral sides are convex. A small section of cartilaginous surface is distally located and spans the entire mediolateral width. It is very smooth with an apparent central cleft. Its approximate mediolateral width is about 40.6 mm and its dorsoventral height is about 15 mm towards the medial side. Above the cartilaginous surface, the bone is concave and rugose. Rugosity becomes smooth towards the dorsal margin, where foramina are absent.

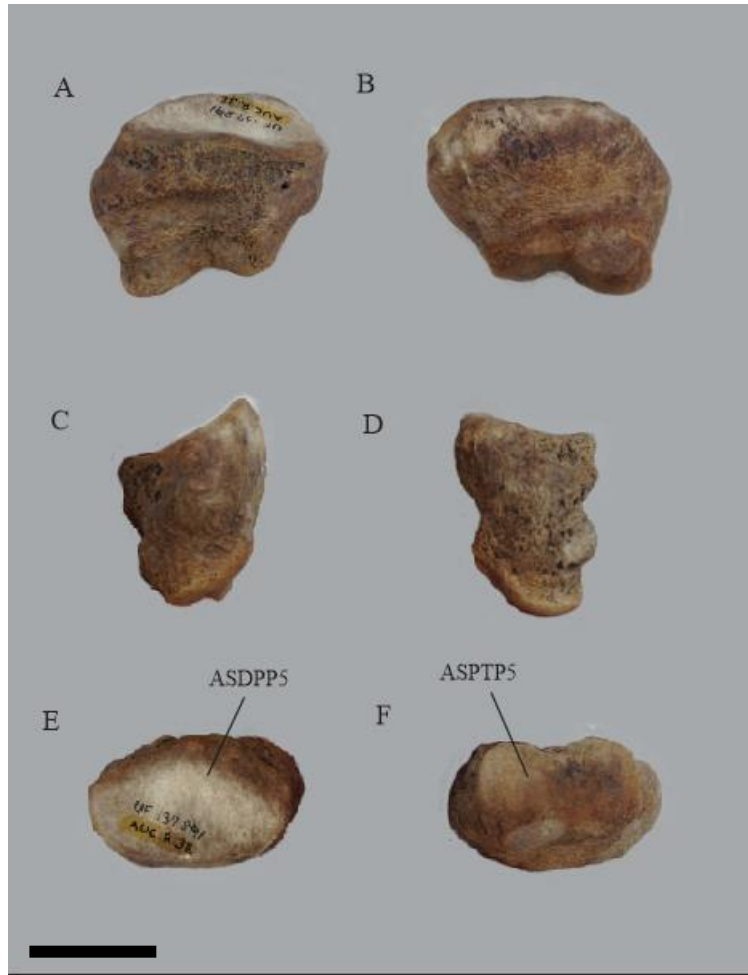


Figure 54: Left medial phalanx of digit V of UF 137891. A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASPTP5, articular surface to the posterior surface of the terminal phalanx of digit V; ASDPP5, articular surface of the distal surface of the proximal phalanx of digit V. Scale bar = 5 cm.

Sesamoids

There are several sesamoids for the left manus, although their articulation points are unknown. All the sesamoids have the typical shapes: circular, tear-dropped, and oval. Many have the medial articular surface where they fuse with a medial or lateral pair.

CHAPTER 5. *Amebelodon britti* FROM MOSS ACRES RACETRACK

Left Manus

The shovel tusked gomphothere, *Amebelodon britti* (UF 69997), has left manus carpals and metacarpals.

Carpals

Pisiform. The pisiform (Figure 55) connects with the cuneiform by a proximally oriented articular surface on the medial side of the bone and with the ulna by an articular facet on the dorsal surface. Overall, the bone is pinched mediolaterally and tapers to a ventral tip. Its greatest dorsoventral length is 159.0 mm and its greatest anteroposterior width is 96.0 mm. Pisiform is almost complete, missing only a posterior fragment.

In dorsal view, the articular surface for the ulna (ASU3) is oval shaped and tapers anteriorly. The surface is smooth and has a dark medial border that it shares with the medial side's articular surface for the cuneiform (ASC4). ASU3'S medial border is the ASC4's dorsal border. Overall shape of the dorsal pisiform is tear drop, with the anterior tip making the point and the posterior side creating the convex curvature. Medial side is convex and the lateral side is undulatory, with its convexity anteriorly oriented. Shape of the ASU3 mimics the overall shape of the dorsal pisiform. Its greatest anteroposterior length is 74.7 mm and its greatest mediolateral width is 21.7 mm.

In medial view, the pisiform is anteriorly curved. Dorsal margin is flat; posterior outline is convex; ventral margin is convexly rounded distally; and the anterior margin is concave. Proximal articular surface, ASC4, is flat dorsally and the rest of the border is a single large distally convex curvature. Anteroposterior length is 68.9 mm and its dorsoventral width is 35.1

mm. The surface is smooth and the articular border is flush with the surface. The rest of the bone on the medial side is rugose. Beneath the ASC4, the rugose bone is concave and has small foramina. There is also a rugose ridge of bone running from the proximal posterior corner and down to the anterior side, just below the center. Various sized foramina are scattered throughout the rest of the surface.

In ventral view, the rugose tip of the pisiform is all that is viewable. It is riddled with foramina.

In lateral view, bone is entirely rugose. There is a large proximal nodule, that is rugose but smoother than the rest of the surface. There is also a rugose ridge that is inwardly convex in contour from the center of the anterior side to the distal anterior margin. The bone within the boundary of the extended ridge and the anterior margin is concave. Shape in lateral view is exactly the same as in medial view.

In anterior view, the bone is entirely rugose and concavely curved. The greater concavity is distally oriented and the curvature becomes anteriorly extended proximally. Part of the proximally curvature to the anteriorly extended rugose point is missing. Within the greater concavity, the rugose bone is smoother than the surrounded rugose bone. Distal tip of the pisiform is also more medially oriented.

In posterior view, the whole surface is rugose and riddled with foramina. There are two circular concave depressions that have anteriorly extended borders. The larger depression is in the center of the anterior surface and is more oval shaped, tapering proximally and distally with a wider mediolateral center. Above this depression is the second, and smaller one, which is more circular. The proximal depression connects with the central one. In overall shape, the dorsal

outline is proximally convex whereas the ventral margin is distally convex. Medial side is convex and the lateral side is concave.

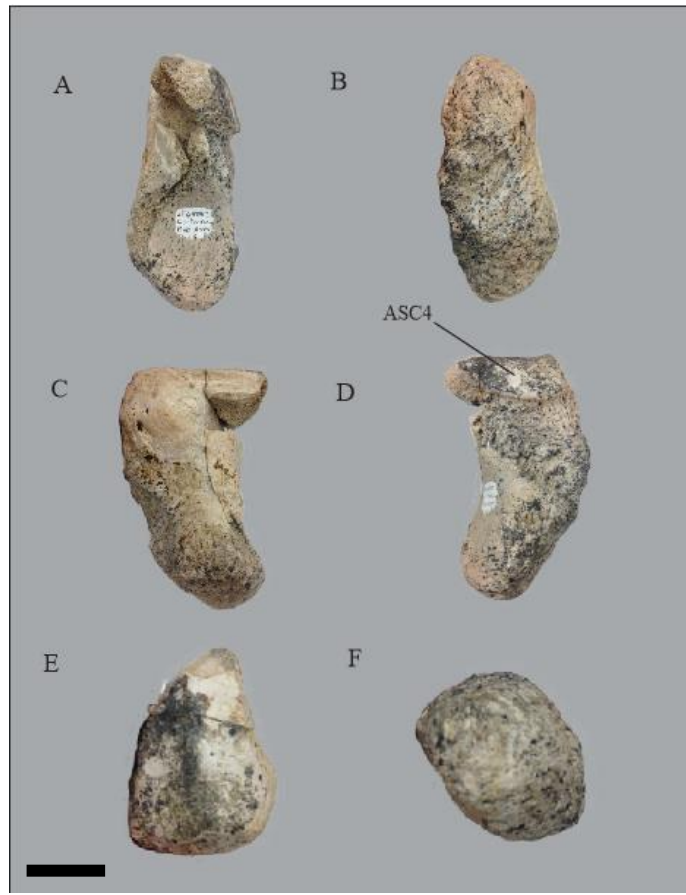


Figure 55: Left pisiform of UF 69997. A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASC4, fourth articular surface for the cuneiform. Scale bar = 5 cm.

Cuneiform. The cuneiform (Figure 56) articulates proximally with the ulna, distally with the unciform, medially with the lunar, and posteriorly with the pisiform. Anteroposterior and mediolateral axes are long whereas the dorsoventral axis is short in comparison. Cuneiform's greatest mediolateral width is 171.0 mm, and the greatest anteroposterior width is 117.0 mm. Cuneiform is almost entirely complete but is missing several fragments on the dorsal, ventral, lateral, and anterior surfaces.

In dorsal view, the cuneiform is triangular shaped with the medial edge forming the base and the lateral projection tapering to the point. Anterior edge is convex and the posterior side is concave and they meet a lateral point that is directed posteriorly. Medial side is slightly concave and the lateral edge forms a sharp point due to missing fragments but would probably have been convexly rounded. Most of the dorsal surface is an articular surface for the ulna (ASU), which laterally terminates as the rugose section of the lateral projection begins. Shape of the ASU is triangular, with the base being the cuneiform's medial side, and the rounded tip laterally oriented. Anterior and posterior sides are convex, with the anterior side more so. ASU shares an articular edge with the articular surface for the pisiform (ASP) that is on the posterior side. ASU is undulating, with the rise close to the anterior side and the fall towards the posterior, before it sharply rises again to the posterior edge. Greatest mediolateral width of the ASU is 98.9 mm, and the greatest anteroposterior length of the ASU is about 128.1 mm. The surface is very smooth. ASP is also in view and is oval, extending beyond the lateral termination of the ASU.

In medial view, both the anterior and posterior curvatures of the cuneiform are convex. Anterior side is thicker than the posterior, and the ASU curves downwards into the cuneiform's medial side. This downward articular surface curvature is about 76.0 mm wide anteroposteriorly with a dorsoventral height of about 10.0 mm. Medial side has an posteroventral articular surface

for the lunar (ASL) that is roughly rectangular shape. ASL terminates past the center of the ventral margin where the articular surface for the unciform (ASUN) borders. In greatest anteroposterior length, the ASL is 71.5 mm and the greatest dorsoventral height is 17.5 mm. The surface is smooth and flush with its articular borders. Between the two articular surfaces, the bone is rugose, concave, and riddled with various foramina.

In ventral view, the entire surface is the articular surface for the unciform (ASUN). Anterior margin is mostly convex but has a central inward depression and the posterior margin is strongly concave. Medial side is relatively flat and the lateral side convexly rounds out. Most of the central surface is smooth but the lateral projection is rough near its laterally extent. Near the anterior portion of the main articulation, two osteolytic features are present with smooth edges.

In lateral view, most of what is visible is the rugose tip of the lateral projection, which is greatly chipped anteriorly, displaying interior cancellous bone.

In anterior view, the ASUN edge has a generalized concave curve, and the ASU edge has an undulating contour. The entire anterior surface is rugose with foramina along the dorsal and ventral margins. Although the general shape of the ASUN edge forms a concave curve for the bottom of the cuneiform, the articular surface is visible on the anterior side as it curves upwards and wraps anteriorly around in the lateral projection.

In posterior view, the ASP is oval and tapers medially. Shared ASU border is flat and the rest of the articular border is distally convex. ASP is flat. Greatest mediolateral width for the ASP is 95.8 mm and its greatest dorsoventral length, laterally oriented, is 39.2 mm. Beneath the facet for the pisiform, the rugose bone is concave. The rest of the bone is rugose and the larger foramina are in the lateral projection. There is also a large rugose nodule on the medial side.

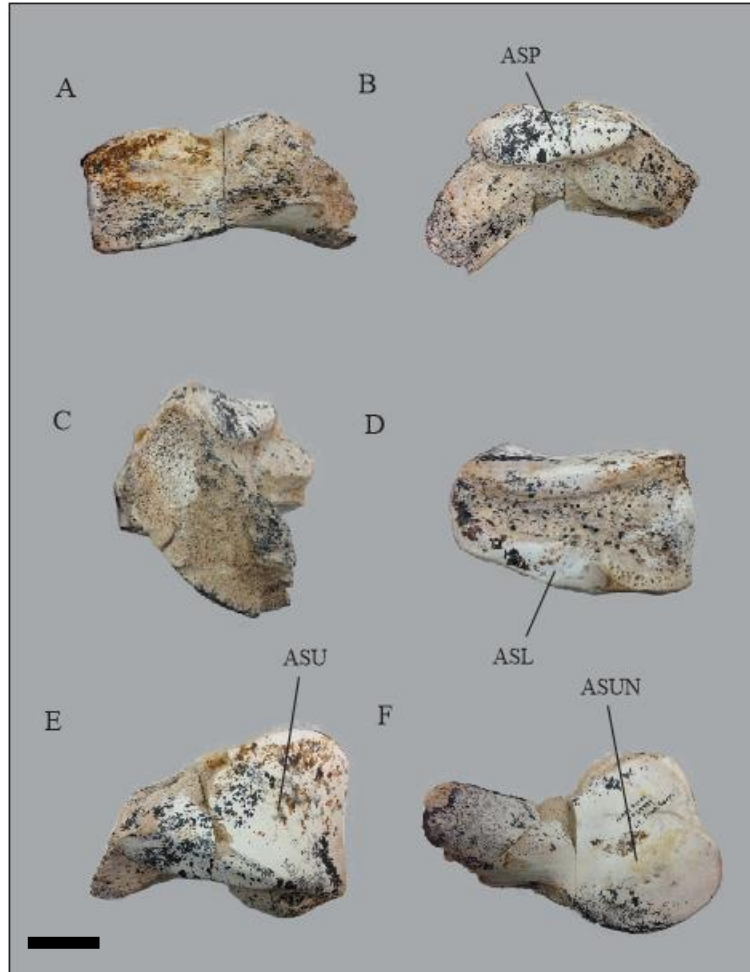


Figure 56: Left cuneiform of UF 69997.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASP, articular surface for the pisiform; ASL, articular surface for the lunar; ASU, articular surface for the ulna; ASUN, articular surface for the unciform. Scale bar = 5 cm.

Lunar. The lunar (Figure 57) articulates proximally with the radius, dorsomedially with the ulna, medially with the cuneiform, distally with the magnum, and laterally with the scaphoid. Lunar is anteroposteriorly elongate with the anterior mediolateral length nearly matching the anteroposteriorly length as a whole, but the mediolateral length narrows significantly towards the posterior extremity. Lunar is dorsoventrally short. Greatest anteroposterior length is 142.0 mm and the greatest mediolateral width is 154.0 mm. Lunar is complete.

In dorsal view, the anteromedial margin of the ASR is also the conjoined border margin for the ASU. Anterior side is moderately straight with a slight convexity whereas the lateral side is straight except for its laterally outward curvature to the anterolateral corner. Medial side has a greater concave curvature with the greatest depression occurring posteriorly to the dorsomedial ASU2. ASU2 itself displays a convex bulge into the medial side, and after the centromedial depression on the medial side, the bone curves into a convexly rounded posterior curvature. ASR is very smooth.

In medial view, there are two articular surfaces: the proximal ASU2 and the distal articular surface for the cuneiform (ASC). ASU2 is very circular, smooth, and has a central concavity. ASU2 has an anteroposterior length of 84.3 mm and a dorsoventral width of 18.5 mm. Distal ASC is rectangular and smooth. ASC has an anteroposterior length of 57.5 mm and a dorsoventral width of 19.2 mm. The rest of the bone is rugose and is concave between the articular surfaces. There is an anterior nodule of bone that extends medial and the posterior tip is a rugose knot. Large foramina are in the central cavity and smaller foramina are throughout the rest of the rugose surfaces. Anterior and posterior sides are convex whereas the dorsal and ventral outlines are concave, especially posteriorly.

In ventral view, the articular surface for the magnum (ASM) takes up the entirety of the bone surface. It is greatly concave from the posterior point up to where the facets appear on the lunar's medial and lateral sides, which is where the rest of the bone up to the anterior side becomes convex. The bone is triangular with an undulatory anterior side that has a concave center, and a concave medial and lateral side. Posterior margin is posteriorly convex. The entire surface is smooth, with no notable porosity.

In lateral view, the bone is relatively flush with the scaphoid's articular surfaces. Rugose bone between the lunar's scaphoid articular surfaces has very little concavity. Foramina are visible in the rugose center. For the overall shape in the lateral viewpoint, the posterior end is convex and well-rounded whereas the anterior end is undulating with the convex curvature occurring distally. Dorsal edge of the bone is concave posteriorly whereas the ventral edge is entirely concave. There are two articular surfaces: the ventral articular surface for the scaphoid (VASS) and the dorsal articular surface for the scaphoid (DASS). DASS is oval shaped and is anteroposteriorly 48.9 mm long and about 14.1 mm in dorsoventral height. VASS is rectangular and is about 82.3 mm long anteroposteriorly and has a greatest dorsoventral height of 19.5 mm. Both surfaces are smooth and the rest of the bone is rugose, with many foramina centrally located.

In anterior view, the anterior side is triangular with the concave ASR and the concave ASU2 curve proximally into a point. Medial and lateral sides are convex and the ventral outline is slightly concave. The entire surface is rugose except for where the ASR distally curves into the proximal anterior side. There is a rugose nodule on both the proximal medial and lateral sides which connect by a mediolaterally oriented ridge.

In posterior view, the point is very rugose with many foramina visible.

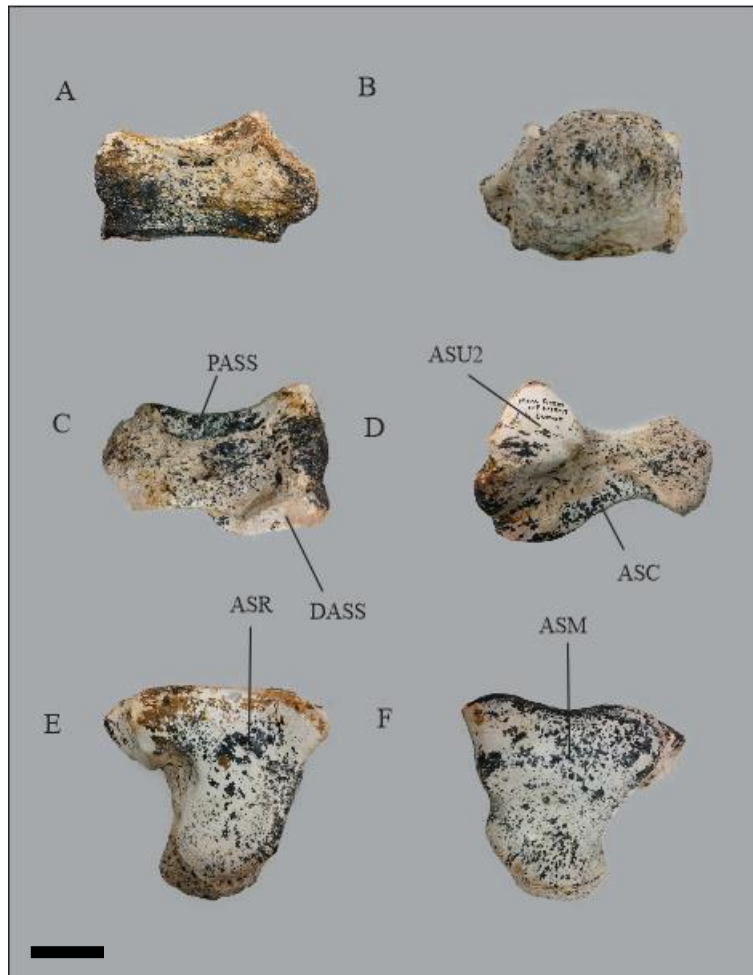


Figure 57: Left lunar of UF 69997.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. PASS, proximal articular surface for the scaphoid; DASS, distal articular surface for the scaphoid; ASU2, second articular surface for the ulna; ASC, articular surface for the cuneiform; ASR, articular surface for the radius; ASM, articular surface for the magnum. Scale bar = 5 cm.

Scaphoid. The scaphoid (Figure 58) articulates proximally with the radius, laterally with the lunar, and distally with the magnum, trapezoid, and trapezium. It is dorsoventrally and anteroposteriorly elongate but narrow mediolaterally. Its greatest dorsoventral length height is 138.0 mm and its greatest mediolateral width is 62.0 mm. It is complete. Like most of the other carpals, its general shape is triangular.

In dorsal view, the circular ASR2 is the most prominent observable feature, though the concave posterior edge, the extended ventral articular surface for the lunar (ASL2) facet, and some of the medial side are also visible around ASR2. Dorsal articular surface for the radius has a conjoined rim that connects with the proximal articular surface on the scaphoid's medial side, which articulates with the proximal articular surface on the lunar's lateral side. This conjoined articular surface is ASL3. ASR2 is smooth without any noted porousness, and much of the articular border is elevated above the articular surface. Greatest anteroposterior length of the ASR2 is roughly 72.9 mm and its greatest mediolateral width is 49.7 mm.

In medial view, three articular surfaces are visible: distal ASL2, proximal ASL3, and the distal articular surface for the magnum, trapezoid, and trapezium (ASMTDTM). The oval ASL2 is long, slender, and smooth with the articular surface flush with the articular rim. Greatest anteroposterior length of ASL2 is 58.1 mm and its greatest dorsoventral height is 23.2 mm. Distal articular surface edge of ASL2 is shared by the medial edge of the articular surface for the magnum, trapezoid, and the trapezium on the scaphoid's ventral side (ASMTDTM). This shared articular rim is also smooth. Proximally, ASL3 is crescent shaped, long and slender, with an anteroposterior length of 55.4 mm and a dorsoventral height of 17.5 mm. The surface is slightly rough and the articular border is flush with the articular surface. ASMTDTM is on the scaphoid's distal surface but it curves slightly up into the medial side and is also smooth with no porousness

visible and its surface is flush with its border. Most of the bone between the two articular surface is slightly concave but there is a rugose nodule near the center that extends outwards. Beneath this nodule and extended to the posterior distal corner, there is a concave pocket of smoother rugose bone.

In ventral view, the ASMTDTM is most prominent and is a long oval, with a flat shared edge with the ASL2. ASMTDTM has its greatest anteroposterior length at 107.8 mm and its greatest mediolateral width at 49.7. Articular surface is very smooth and the medial articular rims is raised from the surface whereas the rest of the border is flush with the rims.

In lateral view, the entire surface of bone is rugose and many foramina or observable. There is only one laterally extending rugose ridge that starts at the center of the anterior outline and runs to the near center of the ventral outline. Distal anterior corner is depressed from this ridge.

In anterior view, the rounded anterior edge is all that comprises the scaphoid's anterior side. Part of the ASR2 is proximally apparent and there is an anteriorly expanded knot of bone in the center of the edge. The rugose nodule is smoother laterally with soft tissue fibrous attachments directed mediolaterally. The rest of the bone is rugose and foramina are scarce.

In posterior view, a large, convexly curved edge between the lateral and medial sides is all that is present. The bone nodule that was visible on the medial side is also noted here, extending medially. There is also a rugose ridge near the proximal end that starts at the medial margin and extends down to the center of the lateral margin. The rugose posterior ridge is entirely made up of mediolaterally oriented fibrous soft tissue attachment threads. Posterior

edge's greatest convexity is located near its distal limit. Many small foramina are scattered about on this curvature.

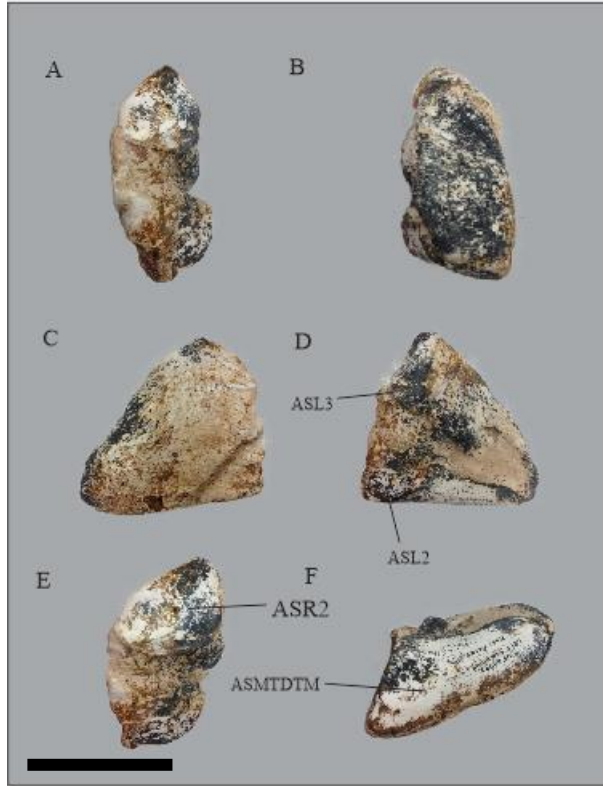


Figure 58: Left scaphoid of UF 69997.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASL2, second articular surface for the lunar; ASL3, third articular surface for the lunar; ASR2, second articular surface for the radius; ASMTDTM, articular surface for the magnum, trapezoid, and trapezium. Scale bar = 5 cm.

Unciform. The unciform (Figure 59) articulates proximally with the cuneiform, medially with the magnum, ventromedially with the third metacarpal, distally with the fourth metacarpal, and laterally with the fifth metacarpal. Unciform is mediolaterally and anteroposteriorly elongate, and dorsoventrally shorter. Greatest mediolateral width is 143.0 mm, whereas the greatest anteroposterior length is 141.0 mm. Unciform is complete.

In dorsal view, the shape of the unciform is trapezoidal. Anterior margin is mostly convex but with a slight central dip, and the posterior, lateral, and medial margins are concave. Lateral margin is almost straight however, and the posterior margin has only the slightest concavity with a central depression. Medial side has a strong concavity, unlike the rest of the outlines, and forms a sharp corner with the anterior outline. The entire dorsal surface is the articulated surface for the cuneiform (ASC2). ASC2 is mostly smooth but there is significant porosity along the posterolateral corner and some just past the anterolateral corner along the anterior margin. Anterior porous section is depressed from the rest of the articular surface, but the posterior section is not. Along the medial edge, the surface is also depressed beneath a ridge of raised articular surface. This area is still smooth.

In medial view, the unciform is trapezoidal. The longer base is the rounded posterior side with its large rugose protrusion and the smaller base is the concave anterior side. Ventral side is convex and the dorsal margin is undulatory. Both the dorsal and ventral outlines have their greatest concavities anteriorly. In the medial view, the articular surface for the magnum (ASM3) is most prominent and there is also a small distal articular surface for the distal articular surface on the medial side of the magnum (ASM5) and the articular surface for the third metacarpal (ASMC3) is located beneath it. Dorsal edge of the proximal articular surface (ASM3) shares a conjoined facet border with ASC2's medial edge. ASM3 is long, broad, and flat with a concave

ventral edge. Its greatest dorsoventral height is 68.2 mm on the posterior end whereas its minimal dorsoventral height, in the central area, is about 44.2 mm. Its anteroposterior length is 113.1 mm. Much of the distal ASMC5 is chipped but it looks like it was long and it is slender. Its greatest dorsoventral height is about 8.4 mm. Both articular surfaces are smooth and flush with their articular borders. Anteriorly, the ASM3 and the ASM5 almost connect anterior, with only a thin concave channel of rugose bone between, which widens out posteriorly. Few foramina are noted.

In ventral view, the unciform is very triangular, with the anterior side making the base and the posterior end comprising the point. The anterior curvature, which is very slightly convex, is more anteriorly extended at its medial corner and slopes down to its lateral corner. Medial and lateral sides are slightly concave. There are three articular facets on the ventral side: the medial ASMC3, the central articular surface is for the fourth metacarpal (ASMC4), and the lateral articular surface that articulates with the fifth metacarpal (ASMC5). Anteroposterior length of the ASMC3 is 108.6 mm and its greatest mediolateral width is 37.6. Anteroposterior length of the ASMC4 is 100.1 mm and its central mediolateral width is 56.2 mm. Anteroposterior length of the ASMC5 is 81.5 mm and its central mediolateral width is 49.7 mm. ASMC3 is roughly rectangular shaped and slants proximal towards the medial side. It is moderately smooth except for a porous posteriorly. ASMC4 is trapezoidal in shape, with the posterior edge making the smaller base and the slanted anterior side making the larger one. Its straight shared borders with the ASMC3 and ASMC5 make the sides. This surface is mostly smooth but is porous along its posterior edge and along its shared depressed border with the ASMC5. A large osteolytic pathology is located close to the center of the shared ASMC3 border and has smooth edges. The short rectangular (compared to ASMC3) ASMC5 is only smooth in its center near the shared

ASMC4 border and is porous and roughly textured everywhere else. It slants proximally towards the lateral side and has some articular surface on that side. All three articular surfaces are flush with their borders. The large posterior rugose protrusion extends posteriorly beyond the articular surfaces and some of the rugose anterior side is visible beyond the articular surfaces from the anterior's center and more so towards its lateral corner.

In lateral view, very little of the ASMC5 is present but it does connect with some of the ASC2 that has curved downwards laterally. This ASMC5 surface is roughly textured and flush with its anterior, posterior, and ASC2 borders.

In anterior view, the bone is trapezoidal with the dorsal outline making the slightly concave large base and the ventral outline making a very small flat base. Both the lateral and medial outlines flatly extend to the proximal corners until they reach very large and rounded rugose nodules that comprise the anterior proximal medial and lateral corners. This side is very rugose and has many foramina.

In posterior view, the unciform shape is triangular, with the base formed by the dorsal side and the point being the distal rugose posterior knot of bone that points to the medial side. The entire side is rugose and has two large central concave pockets filled with large foramina.

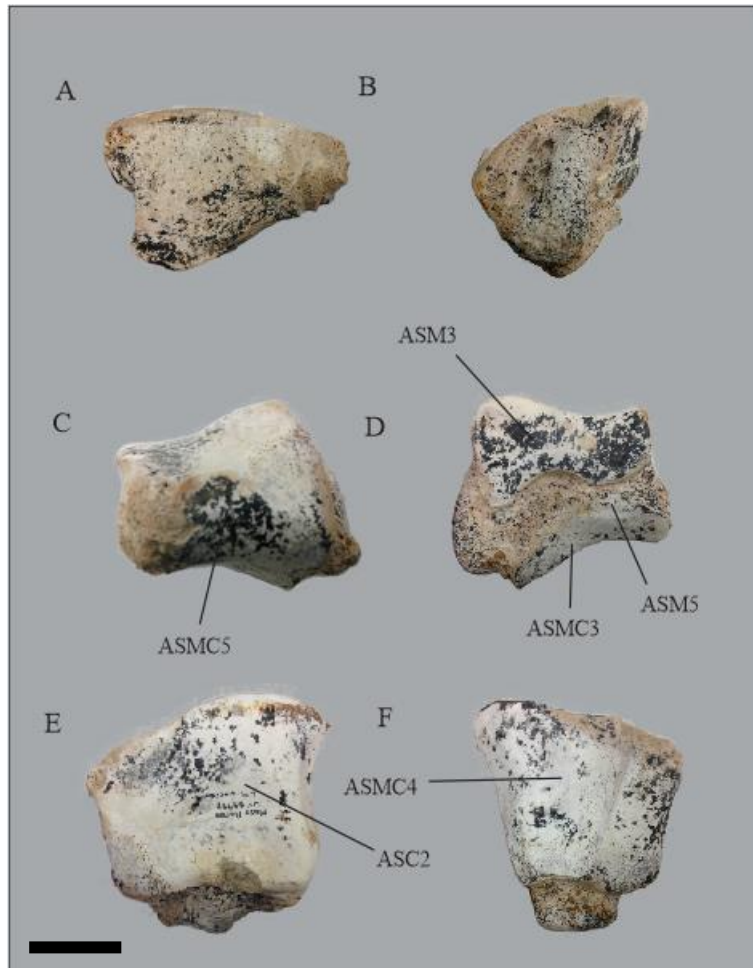


Figure 59: Left unciform of UF 69997.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASM3, third articular surface for the magnum; ASMC3, articular surface for metacarpal V; ASMC4, articular surface for metacarpal IV; ASMC5, articular surface for metacarpal V; ASC2, second articular surface for the cuneiform. Scale bar = 5 cm.

Magnum. The magnum articulates proximally with the lunar, medially with the unciform, distally with the third metacarpal, and laterally with the trapezoid. Anteroposterior axis is the longest, followed by the dorsoventral, and the shortest axis is the mediolateral one. Greatest anteroposterior length is 141.0 mm, and the greatest mediolateral width is 107.0 mm. Overall magnum shape is square and blocky. Magnum is complete.

In dorsal view, the entire surface is comprised of the articular surface for the lunar (ASL4). ASL4 mostly flat anteriorly but has a large posterior dome. Medial side of the ASL4 is mostly straight with the slightest central dip but the anterior edge is undulating with its greatest convexity posteriorly oriented and the greatest concavity in the center before it expands back out to the anterolateral corner. Posterior and anterior sides are convex. Overall, the ASL4 is smooth with no porousness and there is a large osteolytic pathology in the center, just before the posterior dome extends proximally. There is another small osteolytic pathology forming laterally just above the first. Both have smooth edges and the larger hole causes the surface to darken around it.

In medial view, the shape in this view is trapezoidal, with the larger and rounded base being the convex posterior curvature and the anterior side forming the smaller flat base. Ventral margin is concave, and the dorsal margin is anteriorly flat before posteriorly doming. There are two articular surfaces on the medial side: the proximal articular surface (ASUN2) correlates with the proximal articular surface on the unciform's medial side and the distal articular surface that articulates with the distal articular surface on the unciform's medial side (ASUN3). The smooth ASUN2 stretches from the anterior edge to the posterior edge and has a rounded posterior end, a concave ventral border, and a relatively flat dorsal border before the posterior doming. ASUN2 has an anteroposterior length of 110.0 mm and a greatest mediolateral width of 68.7

mm. ASUN2 is smooth, flush with its articular borders, and has a large osteolytic pathology close to its dorsal margin in the posterocentral area. ASUN3 is a small triangular shaped articular surface with raised articular borders and a rough and porous center. ASUN3 has an anteroposterior length of 44.6 mm and a mediolateral width of 15.9 mm. Beneath it, on the ventral side, is the articular surface for the third metacarpal's proximal articular surface (ASMC3(2)). ASUN3 and the ASUN2 touch but are not fused. Between the two surfaces posteriorly, the bone is concave, rugose, and riddled with small foramina before extending to the posterior protrusion. Anterior of the two articular surfaces, there is a rugose, triangular nodule.

In ventral view, the main articular surface is the ASMC3(2). ASMC3(2) is long and oval shaped, with a flatter, but slightly convex, anterior side. ASMC3(2) is 105.0 mm in anteroposterior length and has a greatest width of 73.0 mm. It is smooth and shares a lateral border with the articular surface for the second metacarpal (ASMC2). ASMC2 is similar in shape and curves proximally towards the lateral side. It is 100.6 mm in anteroposterior length and 40.7 mm in mediolateral width. It is concave and mostly smooth but has posterior porosity. Shared border between the two articular surfaces is smooth without any signs of wear.

In lateral view, the shape is trapezoidal like it is on the medial side. There are two articular facets that have fused into a single large one. It has a proximal and anterior section. Proximal articular surface correlates with the proximal articular surface on the trapezoid's medial side (ASPTD), and the same is for the anterior section (ASATD). ASPTD's dorsal edge is flat, its posterior end flat, its central margin is concave. ASATD's edges are all straight except for the concave posterior margin, which curves with the ASPTD's concave distal margin. ASPTD has an anteroposterior length of 105.0 mm and a posterior dorsoventral width of 41.7 mm, which is

the maximal width. ASATD's dorsoventral length is 74.0 mm and the central mediolateral width is 36.94 mm. Articular surfaces are entirely smooth. The anterior portion is flat whereas the dorsal portion is centrally concave, and the rest of the bone on the lateral side is concave and rugose. Large foramina follow the articular curvatures.

In anterior view, the magnum is square and is entirely rugose. The surface has a large circular knot that extends anteriorly, though not greatly so. Foramina are all throughout the anterior surface.

In posterior view, the magnum's shape is triangular and it is almost entirely rugose. ASL4 makes the base and the posteroventral rugose apex becomes the point with the medial and lateral edges making slightly concave sides. Lateral outline does have a greatly extended distal portion that is visible, somewhat distorting the triangular shape. ASL4 also curves downwards into the posterior side and has two large foramina underneath its central articular border. Posterior apex of the ASL4 rounds out just off center on the more lateral side of the posterior surface. When the carpals are articulated, only the posterior point of the lunar surfaces covers the dorsal articulation that has curved into the posterior side. Corners of the dorsal facet are left uncovered by the lunar. Medial corner gets partially covered by the ventral cuneiform as it connects with the lunar and on the lateral side, that posterior corner gets covered by part of the scaphoid as it connects with the lunar. Beneath the ASL4 in the posterior side, there is a concave channel. Concavity ends when the posterior rugose protrusion starts, which has soft tissue attachment fibers wrapping around it.

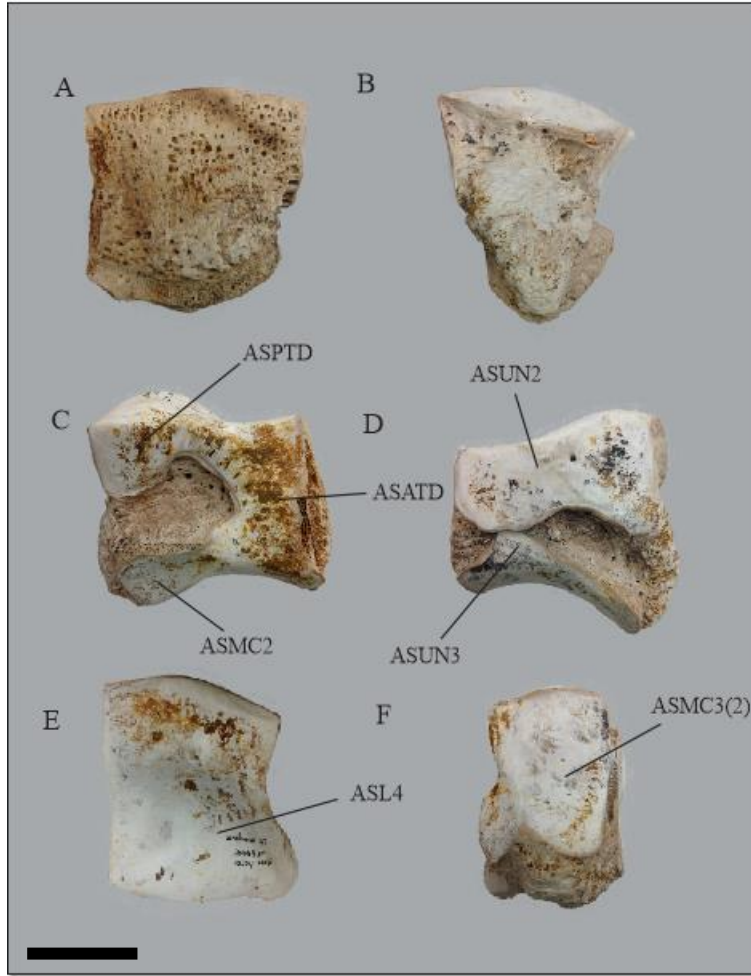


Figure 60: Left magnum of UF 69997.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASPTD, articular surface of the proximal trapezoid; ASATD, articular surface of the anterior trapezoid; ASDTD, articular surface of the distal trapezoid; ASL4, fourth articular surface of the lunar; ASMC2, articular surface for metacarpal II; ASMC3(2), second articular surface for metacarpal III; ASUN2, second articular surface for the unciform; ASUN3, third articular surface for the unciform. Scale bar = 5 cm.

Trapezoid. The trapezoid (Figure 61) articulates proximally with the scaphoid, medially with the magnum, distally with the second metacarpal, and laterally with the trapezium. It is anteroposteriorly elongate and both mediolaterally and dorsoventrally narrow. Greatest anteroposterior length is 120.0 mm and its greatest mediolateral width is 92.0 mm. Trapezoid is complete.

In dorsal view, the trapezoid shape is somewhat triangular. Medial outline has an undulatory curvature from the anteromedial corner to the posterior point, with the convex portion anteriorly oriented and the inward curvature beginning in the center of the medial side and rounding out to the posterior point. Anterior edge is slightly convex with the medial corner more anteriorly extended than the lateral corner. Most of the dorsal surface is comprised of the concave articular surface for the overlying scaphoid (ASS), except for some rugose anterior bone that starts in the center, beyond ASS's articular margin, and expands to the lateral corner. Proximal articulated surface for the magnum (ASPM) on the medial side is visible but does not curve into the dorsal plane. Articular surface is entirely smooth and the anterior articular margin is raised above the surface.

In medial view, the trapezoid is trapezoidal. Posterior curvature makes the smaller base whereas the anterior side makes the larger base. Articular border on the anterior side is flat but a rugose distal protrusion expands beyond it. Ventral outline is concave whereas the posterior outline is convex. Dorsal outline is flarily flat. There are also two different surface areas for articulation with the magnum's lateral side that are combined into essentially one large articular surface: proximal (ASPM) and anterior (ASAM). Anteroposterior length of the ASPM is 106.6 mm and the dorsoventral width is 35.7 mm. ASAM is 73.4 mm in dorsoventral length and has a mediolateral width of 35.8 mm. Both surfaces are mostly smooth but the anterior margin is a

little porous. Articular surfaces are flush with their articular borders as well. The rest of the bone is rugose and concave with many foramina, especially anteriorly. Posteriorly, the rugose bones becomes smoother and less concave as it meets up with the posterior side.

In ventral view, the trapezoid has the same shape as on the dorsal side. It is comprised entirely of the articular surface for the second metacarpal (ASMC2(2)). Articular surface is smooth with no obvious porousness. There is a concave tunnel that runs anteroposteriorly through some of the ASMC2(2)'s lateral side, separating it from the articular surface for the trapezium (ASTM) that is on the lateral side and connects with the ASMC2(2)'s lateral border anteriorly.

In lateral view, there is one most prominent articular surface for the trapezium (ASTM). Most of the blocky ASTM stretches from the anterior side to the center of the lateral side and has mostly straight edges except for the convex curvature of the posterior articular border; however, there is a dorsal extension that stretches all the way to the posterior outline and is very thin. Greatest anteroposterior length, taken along the dorsal edge, is 74.6 mm whereas the greatest dorsoventral width is 14.9 mm posteriorly. Anteriorly, the articular surface as an anteroposterior width of 50.6 mm and a dorsoventral height of 49.9 mm. The rest of the bone is concave and rugose with some small foramina scattered about. ASTM is smooth and flush with the articular borders.

In anterior view, the trapezoid is trapezoidal. Medial outline is relatively flat and makes the larger base whereas the slightly convex lateral side is the smaller base. Medial thickness is greater than the lateral thickness. The entire surface is rugose and moderately flat. Very few foramina are noted.

In posterior view, the rugose posterior tip forms a rounded protrusion. On either side of the knot, the medial and lateral sides are visible as they expand outwards. Above the center of the posterior nodule, there is the proximal triangular point where the ASS and ASPM connect. The protrusion is smooth with soft tissue attachment fibers running mediolaterally.

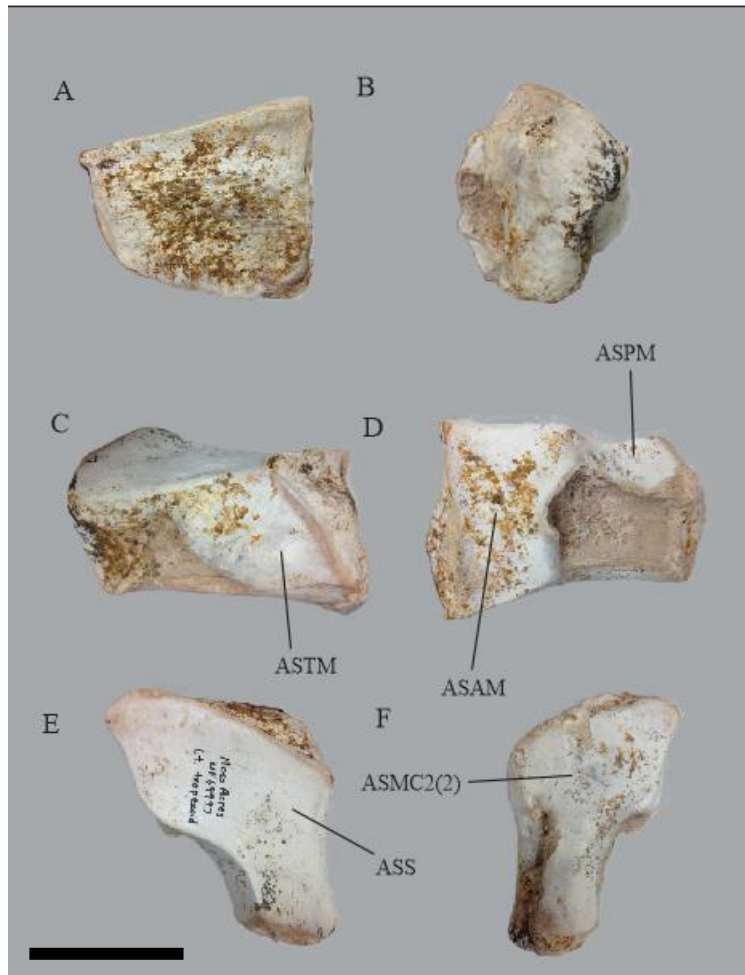


Figure 61: Left trapezoid of UF 69997.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASPM, articular surface of the proximal magnum; ASAM, articular surface of the anterior magnum; ASTM, articular surface for the trapezium; ASS, articular surface for the scaphoid; ASMC2(2), second articular surface for metacarpal II. Scale bar = 5 cm.

Trapezium. The trapezium (Figure 62) articulates proximally with the scaphoid, medially with the trapezoid, and laterally with the first metacarpal. Mediolateral and dorsoventral axis are nearly equal in length and larger than the anteroposterior axis. Trapezium's greatest mediolateral length is 100.0 mm, and its greatest dorsoventral height is 91.0 mm. General shape of the trapezium is a cylinder. Trapezium is complete.

In dorsal view, there is only one articular surface, which associates with the overlying scaphoid (ASS2). Medial edge is straight and the rest of the outline curves convexly into the rugose area. It is 66.0 mm anteroposteriorly length and has its greatest mediolateral wide at 30.8 mm. ASS2 is rough and the articular borders are raised above the articular surface.

In medial view, there is only the articular surface for the lateral side of the trapezoid (ASTD). ASTD dorsal's edge is straight, which is also the conjoined medial edge of the ASS2. Most of the ASTD is an anterior large circular articular area, but it has a proximal thin finger of articular surface that runs postereriorly. ASS2's proximal anteroposterior length is 71.7 mm and its dorsoventral height is 14.6 mm posteriorly. In the main cirucar surface, the anteroposterior width is 39.2 mm and its greatest dorsoventral height is 52.9 mm. The circular surface is raised above the proximal extension but both surfaces are moderately smooth; however, in the center of the circular surface, there is a osteolytic pathology that started posteriorly and ran, expanding, anteriorly.

In ventral view, the rugose bone has an anterior articular surface that shares a border with the ASS2. This articular surface (ASMC4(4)) articulates with the proximal articular surface on the lateral side of MC4. This concave articular surface is smooth and flush with its articular borders. It is 36.0 mm in mediolateral width and 34.7 mm in anteroposterior length. The rest of

the bone is rugose and is concave posteriorly. Foramina are concentrated in the center of the rugose bone.

In lateral view, there is only the oval articular surface for the first metacarpal (ASMC1). ASMC1 is smooth towards the ventral side and rough near the dorsal margin. Anteroposterior length is 82.0 mm and its width is 53.7 mm. The articular surface is flush with the articular border.

In anterior view, the bone is entirely rugose and has a mediolateral dorsoventral ridge distally. Foramina are scattered throughout the surface.

In posterior view, only a rugose edge is present, and foramina are observed throughout the rugose bone.

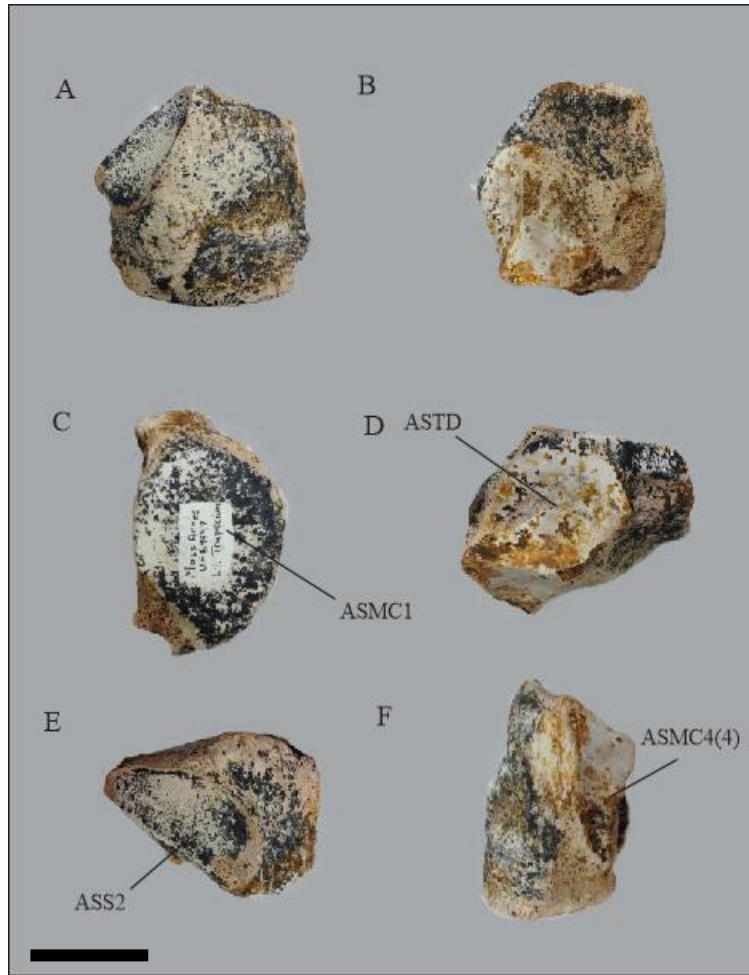


Figure 62: Left trapezium of UF 69997.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASMC1, articular surface for metacarpal I; ASTD, articular surface for the trapezoid; ASS2, second articular surface for the scaphoid; ASMC4(4), fourth articular surface for metacarpal IV. Scale bar = 5 cm.

Metacarpals

Metacarpal I. The first metacarpal (MC1) (Figure 63) articulates proximally with the trapezium, and distally with the proximal phalanx for the first digit and two sesamoids. MC1 is dorsoventrally elongate, with narrow mediolateral and anteroposterior axes; however, the MC1 is broken, missing its distal end. Its preserved dorsoventral length is 111.0 mm; and its greatest mediolateral width is 101.0 mm.

In dorsal view, rugose posterior bone and the articular surface for the trapezium (ASTM2), are observed. ASTM2 is very concave with the posterior margin elevated compared to the anterior margin. ASTM2's anteroposterior length is 81.5 mm and the mediolateral width is 58.0 mm. The smooth oval surface is very symmetrical and has a depression line contouring the articular surfaces shape posteriorly. The depressed surface curves up to the posterior border, which is raised above the articular surface as is the rest of the articular border. Posterior to the ASTM2, there is a large rugose ridge that stretches from the lateral side to the center of the posterior side. This rugose bone is moderately smooth with some foramina located along the margin of the ASTM2.

In medial view, the bone is rugose. Anterior and posterior curvatures are concavely inward into the MC1 shaft. ASTM2 is in view as the whole surface is tilted towards the medial side. There is a chipped surface that looks like a rugose nodule was present. Beneath the ASTM2 margin, the rugose bone is depressed and filled with foramina. Near the center and towards the distal end, soft attachment fibers are oriented from the anterior side and up and across to the posterior proximal end.

In ventral view, cancellous interior bone is observed due to the distal breakage.

In lateral view, the overall shape reflects that described for the medial side and the bone is rugose with no articular surfaces. Proximal posterior corner is very rugosely bulbous and smoother than the rest of the rugose lateral side. Posterior protrusion extends down the center of the lateral side, with the soft tissue fibers following the curvature. MC1 shaft is concave beneath the posterior protrusion. Anterior side is not as concave as the posterior and very little foramina are seen.

In anterior view, the bone is rugose and moderately flat proximally. Beneath the ASTM2's articular border, the rugose bone is slightly depressed and filled with foramina. Most of the rugose bone is smooth.

In posterior view, the medial and lateral sides are concave and the dorsal outline is slanted from the medial side and up to the lateral. There is a large rugose knot of bone that is greatly extended at the proximal lateral corner and cuts across, almost to the medial side. It is moderately smooth and the soft tissue attachment fibers run dorsoventrally. Beneath the protrusion, the rugose bone is rougher and concave. In the dorsoventral center of the MC1 shaft, a slim rugose ridge curves up to the protrusion where it connects.

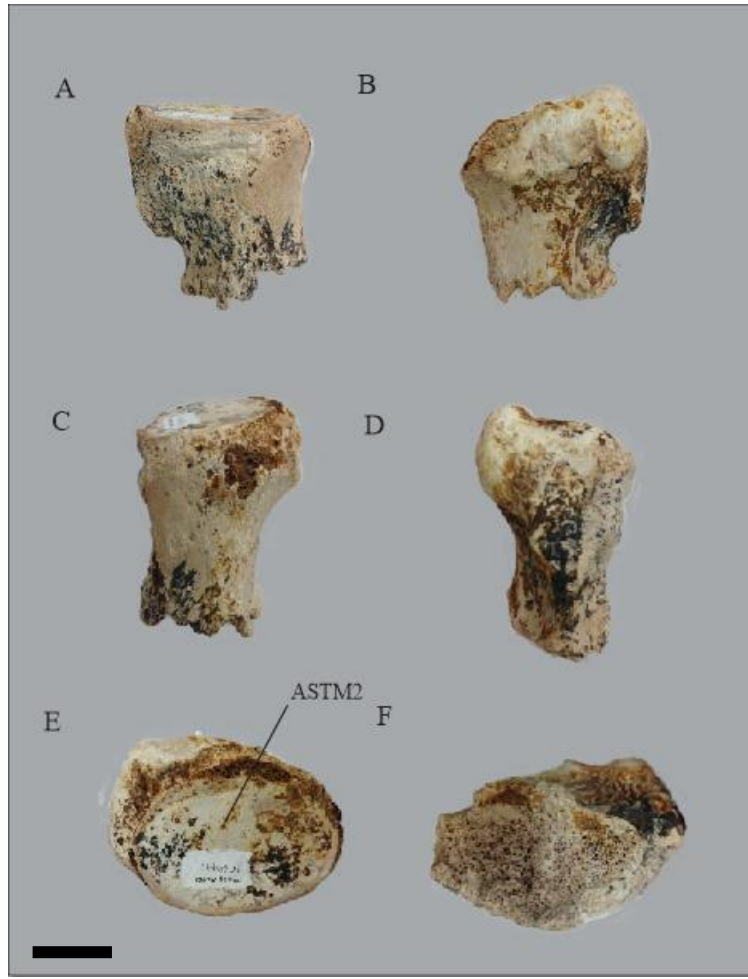


Figure 63: Left Metacarpal I of UF 69997.
A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASTM2, second articular surface for the trapezium. Scale bar = 5 cm.

Metacarpal II. The second metacarpal (MC2) (Figure 64) articulates proximally with the trapezoid, dorsomedially with the magnum, medially with MC3, laterally with the trapezium, and distally with the proximal phalanx for the second digit (AS2PP) and two sesamoids. As a typical metacarpal, MC2 is dorsoventrally elongate and mediolaterally and anteroposteriorly narrow; however, MC2 is broken, missing its distal end. Its preserved dorsoventral length is 120.0 mm; and its greatest mediolateral width is 120.0 mm.

In dorsal view, the MC2 is somewhat trapezoidal. Anterior outline is mostly flat, and is the wider base, whereas the posterior outline is convexly rounded and comprises the smaller base. Medial side is also mostly flat whereas the lateral side is greatly concave. There are two articular surfaces that have a connective border. Main articular surface (ASTD2) articulates with the trapezoid's distal surface (ASMC2(2)). The smaller, more medial articular surface (ASLM) articulates with the distal articular surface on the lateral side of the magnum (ASMC2). Connective articular margin between the two surfaces is inwardly convex, beginning near the anteromedial corner and terminating in the center of the posterior margin. Anteroposterior length of ASTD2 is 99.0 mm and its greatest mediolateral width, which is anteriorly located, is 85.0 mm. Its most narrow in its posteriorly with a mediolateral width of 29.2 mm. Anteroposterior length of the ASLM is 99.9 mm and the greatest width is 35.5 mm. Both surfaces are smooth, including the conjoined ridge between them, and the ASLM is more elevated than the ASTD2. The larger ASTD2 is almost T-shaped whereas the ASLM is very oval.

In medial view, MC2 has concave anterior and posterior sides whereas the dorsal outline is subtly convex. The greatest concavity is seen just below the proximal articular surface (ASMC3(3)), which articulates with the proximal articular surface on the lateral side of the third metacarpal (ASMMC2). MC2's medial side is composed of rugose bone with a few large

foramina visible, which are concentrated beneath the ASMC3(3). The concavity wraps around the ventral and posterior outline of the articular surface, and it has several foramina within. This articular surface is a long slender rectangle that is smooth. There is a ridge contouring the distal margin where the articular surface is depressed between it and the articular rim. Anteroposterior length of the ASMC3(3) is 88.8 mm and its dorsoventral height is 34.2 mm. Articular rims are flush with the articular surface. The rest of the bone surface is rugose with no obvious ridges or nodules.

In ventral view, the interior cancellous bone is visible due to the distal breakage.

In lateral view, there is a small proximal anterior articular surface (ASTM3) that articulates with the trapezium's articular surface on the ventral side. The surface has a straight dorsal edge, which shares the ASTM2, and the remaining rims are distally convex. It has an anteroposterior length of 39.7 mm and a dorsoventral width of 24.6 mm. This surface is smooth and has raised articular rims. The remaining bone in lateral view is rugose. Beneath the dorsal articular border margin and the anterior articular surface, the bone is slightly concave with several large foramina. Proximally, there is a rugose nodule that sits beneath the concave channel and is posteriorly directed. Rugose bone is concave beneath the nodule.

In anterior view, the bone is entirely rugose. Lateral outline is mostly flat but with the slightest concavity; the medial side is more concave. Proximal surface has soft tissue attachment scarring with the fibers running mostly dorsoventrally with a slight medial slant.

In posterior view, there is a large rugose protrusion centrally located with attachment fibers webbing around it. The bone is very concave beneath this posterior protrusion and few

foramina are visible in the rest of the concave rugose body. Medial and lateral sides appear moderately straight and the dorsal margin is elevated near the medial side.

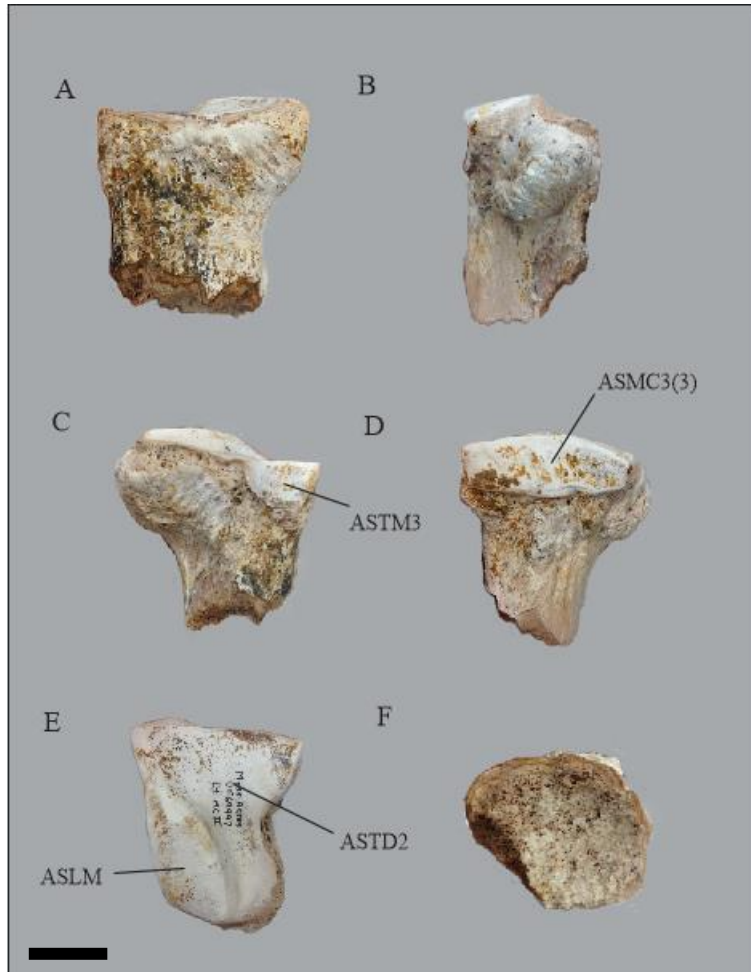


Figure 64: Left Metacarpal II of UF 69997.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASLM, articular surface for the lateral side of the magnum; ASTD2, second articular surface for the trapezoid; ASTM3, third articular surface for the trapezium; ASMC3(3), third articular surface for metacarpal III. Scale bar = 5 cm.

Metacarpal III. The third metacarpal (MC3) (Figure 65) is the largest metacarpal and it articulates proximally with the magnum, dorsolaterally with the unciform, medially with the second metacarpal, laterally with the fourth metacarpal, and distally with the proximal phalanx for the third digit and two sesamoids. It's dorsoventrally elongate and mediolaterally and anteroposteriorly narrow however, the MC3 is broken, missing its distal end. Its preserved dorsoventral length is 115.0 mm and its greatest mediolateral width is 93.0 mm.

In dorsal view, the shape is very triangular with the anterior edge making the base and the rounded posterior making the point. Two articular surfaces encompass the dorsal surface. The first, and more central, is the articular surface for the magnum (ASM4), which articulates with the magnum's distal surface (ASMC3(2)). Its anteroposteriorly 107.9 mm long, and has a central mediolateral width of 66.5 mm. The other dorsal articular surface connects dorsolaterally with the unciform (ASUN3), articulating with the distal articular surface on the unciform's medial side (ASMC3). Its anteroposterior length is 116.0 mm and it is mediolaterally 31.2 mm wide. Both of these articular surfaces share a conjoined border, which forms a medially convex line from the anterior side to the posterior. The connective margin is the highest point of the MC3. ASMC4 is triangular whereas the ASUN3 is rectangular. Both surfaces are smooth; however, the ASMC4 has a few osteolytic features that were starting to form in life. Three are clustered together in the center and one is along the lateral border. ASUN3 has one large osteolytic pathology near the anterior side and is centrally located. Medial and lateral sides are convex whereas the anterior side is concave. Posterior side comes to a rounded triangular point.

In medial view, for the proximal articular surface, the anterior side is flat, the ventral margin is mostly flat with the faintest concavity, and the dorsal margin is convex. Posterior margin comes to a rounded point. These general outlines are also true for the whole MC3, with

what is left at least. Most of the bone is rugose, except for the large proximal articular surface (ASMC2(3)), which articulates with the MC2. ASMC2(3) is somewhat rectangular and has an anteroposterior length of 93.3 mm and a dorsoventral height of 38.4 mm. Most of the surface is smooth but there are two large osteolytic features near the proximal border and centered within the articular surface. They are side by side and are deep but smooth edged. Distally, there is a raised articular ridge and between it and the distal margin, the surface is depressed.

In ventral view, on the cancellous interior bone is in view due to the distal breakage.

In lateral view, the anterior and posterior curvatures are concave whereas the dorsal outline is convex. Most of the lateral bone is rugose but there is a proximal articular surface, which articulates with the fourth metacarpal (ASMC4(2)). This articular surface is a large oval but with a squarely rounded anterior margin. It is at least 88.7 mm in anteroposterior length and has a greatest dorsoventral height of 35.1 mm. This surface is smooth with no porous bone but there are two osteolytic features near the proximal margin and centrally located. They are not deep like the ones on the medial side and are smooth edged. Articular borders are flush with the articular surface. Rugose bone is concave beneath the articular surface with large foramina, and a few small nodules and ridges are below the concavity with many fibrous attachments dorsoventrally oriented.

In anterior view, the bone is entirely rugose. Dorsal margin has a sharp triangular apex that is medially located where the two dorsal articular surface connect. Medial and lateral sides are concave. There is an attachment scar that is proximally convex beneath the dorsal margin with mediolaterally curving attachment fibers. Beneath the curving attachment scar on the medial side, there is a small nodule of rugose bone that is anteriorly extended. Many foramina are scattered along the proximal region.

In posterior view, the lateral side appears straight whereas the medial side has a concave curvature. There is a large rugose proximal protrusion, and the MC3 body becomes concave beneath it before extending back out distally. The rugose bone does not have many foramina or soft tissue attachment fibers and is relatively smooth.

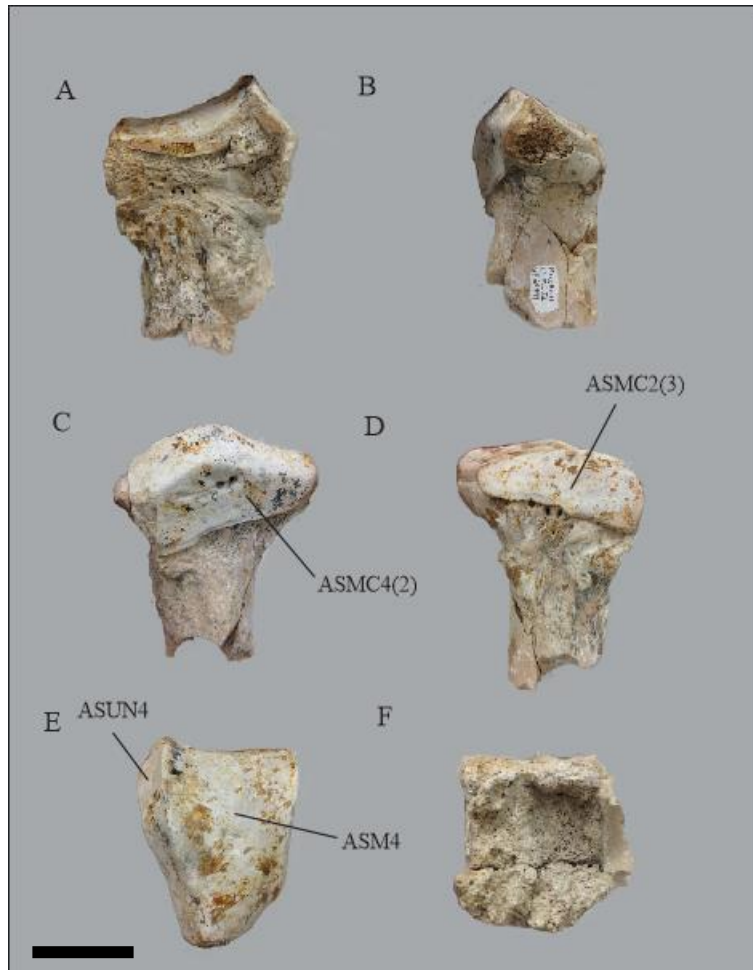


Figure 65: Left Metacarpal III of UF 69997.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASMC2(3), third articular surface for metacarpal II; ASMC4(2), second articular surface for metacarpal IV; ASUN4, fourth articular surface for the unciform; ASM4, fourth articular surface for the magnum. Scale bar = 5 cm.

Metacarpal IV. The fourth metacarpal (MC4) (Figure 66) articulates proximally with the unciform, medially with the third metacarpal, laterally with the fifth metacarpal, and distally with the proximal phalanx associated with the fourth digit and two sesamoids. MC4 is dorsoventrally elongate and mediolaterally and anteroposteriorly narrow; however, the MC4 is broken, missing its distal end. Its preserved dorsoventral length is 119.0 mm and its greatest mediolateral width is 93.0 mm.

In dorsal view, the shape of MC4 is triangular, with the anterior margin forming the base and the posterior end forming the rounded point. The entire dorsal surface is the articular surface that articulates with the distal articular surface of the unciform, or the ASMC4. This surface, ASUN5, is smooth laterally but is mostly rough and porous on the anteromedial corner, medial side, and the posterior tip. Its central mediolateral width is 55.1 mm and its greatest anteroposterior length is 103.5 mm. No rugose bone is visible beyond the articular margins. Anterior margin is subtly convex and the medial and lateral sides are convex, with the medial outline more so. The posterior point is convexly narrow and rounded. In dorsal view, the proximal articular surface on the medial or lateral side is not visible.

In medial view, the main feature is the proximal articular surface, ASMC3(4). This articular surface has a convex proximal margin, concave distal margin, slight convex anterior end, and a straight posterior edge with a more posteriorly extended proximal corner. MC4's proximal margin is much the same as the ASMC3(4)'s. Posterior outline is deeply concave beneath its proximal extension and the anterior margin is also convex. ASMC3(4) is very porous and the articular borders are flush with the surface. Beneath the articular surface, the bone is concave with some foramina. The rest of the bone is rugose, but smoother than within the

concavity and has dorsoventrally oriented attachment fibers. ASMC3(4) is 92.7 mm in anteroposterior length and 37.7 mm in dorsoventral width.

In ventral view, the cancellous interior bone is visible due to the distal breakage.

In lateral view, there is one articular surface. Proximal articular surface articulates with the proximal articular surface on the medial side of the fifth metacarpal, ASMC4(3). MC4's proximal articular surface (ASMC5(2)) is a long and broad oval facet. It is mostly smooth but with some posterior porosity, and the borders are flush with the surface. It has an anteroposterior width of 82.3 mm and a dorsoventral length of 22.0 mm. Rugose bone is slightly concave beneath the articular surface, and very few foramina are visible throughout the rest of the rugose bone. General shape of the MC4 is also similar to the medial side. Dorsal outline is convex and the anterior and posterior outlines are concave.

In anterior view, the entire bone is rugose. Dorsal edge is moderately flat and the medial and lateral sides are slightly concave. There is a proximal concave elongated pit and beneath it, there is a mediolaterally oriented rugose ridge with some foramina. The rest of the rugose surface is smoother.

In posterior view, the bone is rugose. There is a small posterior protrusion that is proximally oriented and extends laterally. The bone is concave beneath it. Rugose bone becomes smoother down the MC4 shaft. Medial and lateral sides are flat but seem to extend distally.

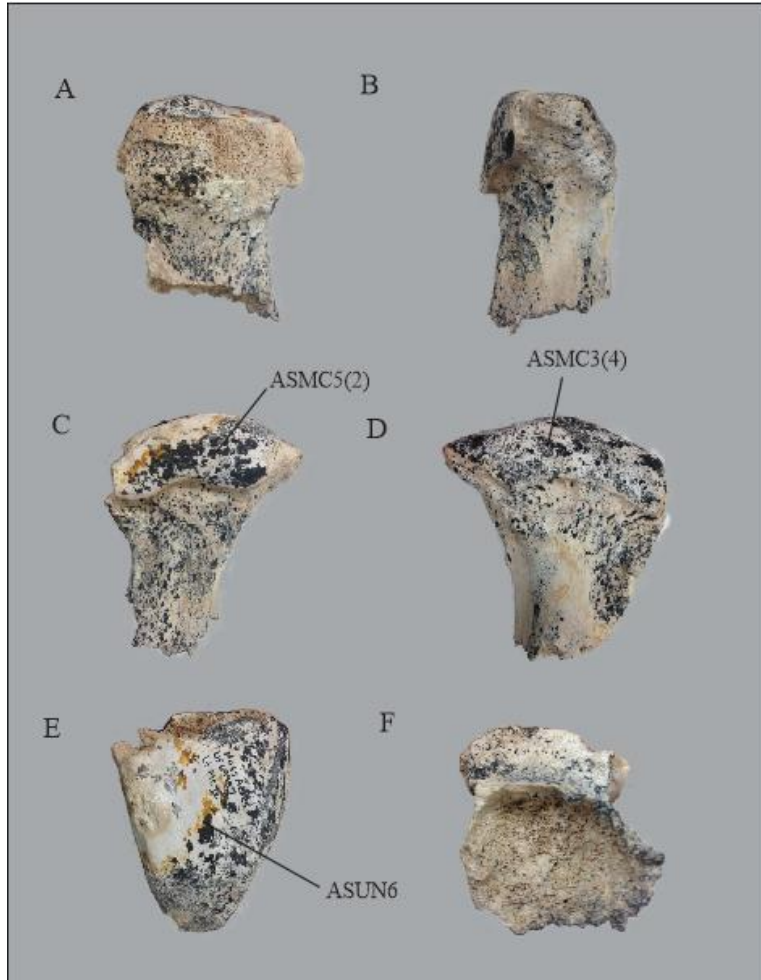


Figure 66: Left Metacarpal IV of UF 69997.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASMC3(4), fourth articular surface to metacarpal III; ASMC5(2), second articular surface to metacarpal V; ASUN6, sixth articular surface for the unciform. Scale bar = 5 cm.

CHAPTER 6. SMALL GOMPHOTHERE FROM MONTBROOK

Right Manus

An undescribed small gomphothere species (UF 423090) has right manus carpals and metacarpals.

Carpals

Pisiform. The pisiform (Figure 67) connects with the cuneiform by a proximally oriented articular surface on the medial side of the bone and with the ulna by an articular facet on the dorsal surface. Overall, the bone is pinched mediolaterally and tapers to a ventral tip. Its greatest dorsoventral length is 94.0 mm; its greatest anteroposterior length is 58.0 mm; and its greatest mediolateral width is 59.5 mm. Pisiform is complete.

In dorsal view, the articular surface for the ulna (ASU3) is oval shaped and narrows anteriorly. The surface is smooth and has a dark medial border that it shares with the medial side's articular surface for the cuneiform (ASC4). Articular border is flush with the articular surface. ASU3'S medial border is the ASC4's dorsal border. Overall shape of the dorsal pisiform is triangular with the anterior tip making the rounded point. Much of the posterior bone is rugose and is visible beyond that articular surface. Its greatest anteroposterior length is 38.6 mm and its greatest mediolateral width is 16.6 mm.

In medial view, the pisiform is greatly anteriorly curved. Dorsal margin is flat; the posterior outline is convex; the ventral margin is convexly rounded distally; and the anterior margin is concave. Proximal articular surface, ASC4, is flat dorsally and the rest of the border is a single large distally convex curvature. ASC4 is very concave and the distal articular surface is raised above the surface. Borders are porous whereas the center is smooth. Anteroposterior

length is 48.7 mm and its dorsoventral width is 28.2 mm. The rest of the bone on the medial side is rugose. Beneath the ASC4, the rugose bone is concave and has small foramina. Various sized foramina are scattered throughout the rest of the surface.

In ventral view, the rugose tip of the pisiform is all that is viewable. It is riddled with foramina.

In lateral view, bone is entirely rugose. Foramina are located along the proximal margin. The distal point is medially oriented.

In anterior view, the bone is entirely rugose and concavely curved. The greater concavity is distally oriented and the curvature becomes anteriorly extended proximally. Within the greater concavity, the rugose bone is smoother than the surrounded rugose bone. Distal tip of the pisiform is also more medially oriented. There is also a rugose ridge that protrudes at the proximal point and extends down to the medial side's center.

In posterior view, the whole surface is rugose and riddled with foramina. There is a small distally convex rugose ridge at the distal tip, that curves from the medial side and to the lateral. On each side of the ridge, the medial and lateral outline have an inward dip. Foramina are scattered throughout the rest of the surface

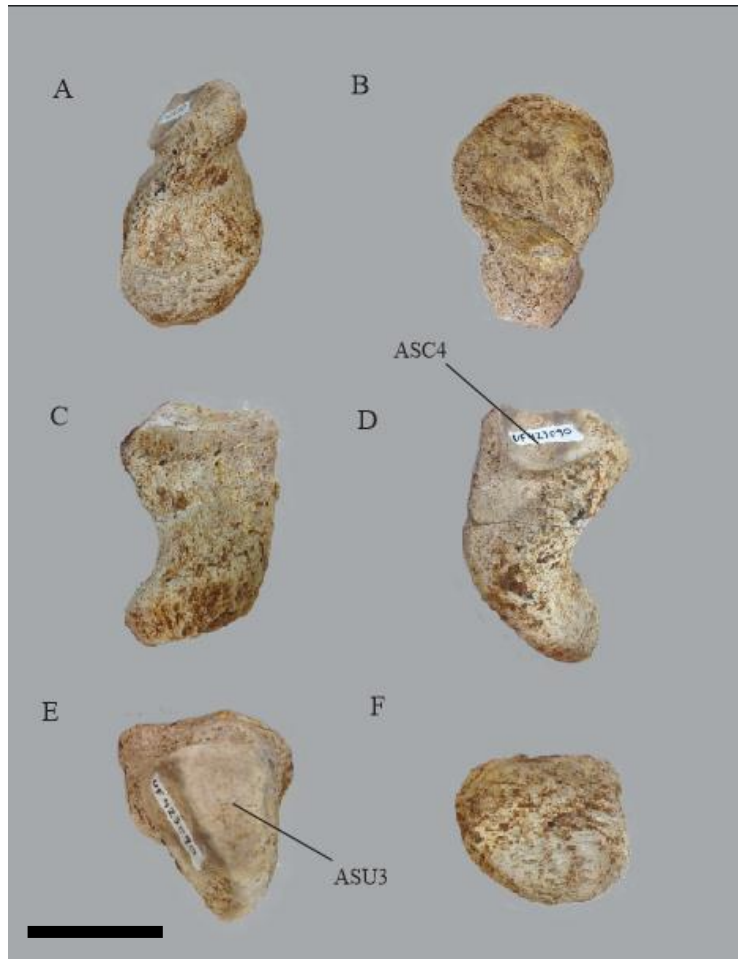


Figure 67: Right pisiform of UF 423090. A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASU3, third articular surface for the ulna; ASC4, fourth articular surface for the cuneiform. Scale bar = 5 cm.

Cuneiform. The cuneiform (Figure 68) articulates proximally with the ulna, distally with the unciform, medially with the lunar, and posteriorly with the pisiform. Anteroposterior and mediolateral axes are long whereas the dorsoventral axis is short in comparison. Cuneiform's greatest mediolateral width is 127.5 mm, and greatest anteroposterior width is 85.0 mm. Cuneiform is complete.

In dorsal view, the cuneiform is triangular shaped with the medial edge forming the base and the lateral projection tapering to the point. Anterior edge is convex and the posterior side is concave and they meet a convexly rounded lateral point that is slightly directed posteriorly. Medial side is slightly concave. Most of the dorsal surface is an articular surface for the ulna (ASU), which laterally terminates as the rugose section of the lateral projection begins. Shape of the ASU is triangular, with the base being the cuneiform's medial side, and the rounded tip laterally oriented. Anterior and posterior sides are convex, almost equally so. ASU shares an articular edge with the articular surface for the pisiform (ASP) that is on the posterior side. ASU is concave. Greatest mediolateral width of the ASU is 62.4 mm, and greatest anteroposterior length of the ASU is about 85.7 mm. The surface is smooth in the center and along the posteromedial corner and is porous everywhere else.

In medial view, both the anterior and posterior curvatures of the cuneiform are convex. Anterior side is thicker than the posterior, and the ASU curves downwards into the cuneiform's medial side. This downward articular surface curvature is about 30.1 mm wide anteroposteriorly with a dorsoventral height of about 5.7 mm. Medial side has a central distal articular surface for the lunar (ASL) that is a slender oval in shape. In greatest anteroposterior length, the ASL is 41.2 mm and the greatest dorsoventral height is 11.8 mm. Both surfaces are porous, the ventral one more so. Proximal articular border is raised above the articular surface for the ASL. Between the

two articular surfaces, the bone is rugose, concave, and riddled with various foramina. Larger foramina are along the dorsal curvature. A rugose nodule is in the center of both the medial and anterior side.

In ventral view, the entire surface is the articular surface for the unciform (ASUN). Anterior margin is mostly convex but has a central inward depression and the posterior margin is strongly concave. Medial side is concave and the lateral side convexly rounds out. Most of the articular surface is lightly porous.

In lateral view, most of what is visible is the rugose tip of the lateral projection, which is riddled with foramina. It curves posteriorly.

In anterior view, the ASUN edge has a generalized concave curve, and the ASU edge has an undulating contour. The entire anterior surface is rugose with foramina along the dorsal margin. Although the general shape of the ASUN edge forms a concave curve for the bottom of the cuneiform, the articular surface is visible on the anterior side as it curves upwards and wraps anteriorly around in the lateral projection. Many of the soft tissue attachment fibers run mediolaterally in the center of the anterior side.

In posterior view, the ASP is oval. The shared ASU border is flat and the the ventral ASP border is almost flat whereas the medial and lateral sides are convex. ASP is flat. Greatest mediolateral width for the ASP is 57.5 mm and its greatest dorsoventral length, laterally oriented, is 28.8 mm. Beneath the facet for the pisiform, the rugose bone is concave. The rest of the bone is rugose and the larger foramina are in the concavity. There is also a small rugose nodule on the medial side.

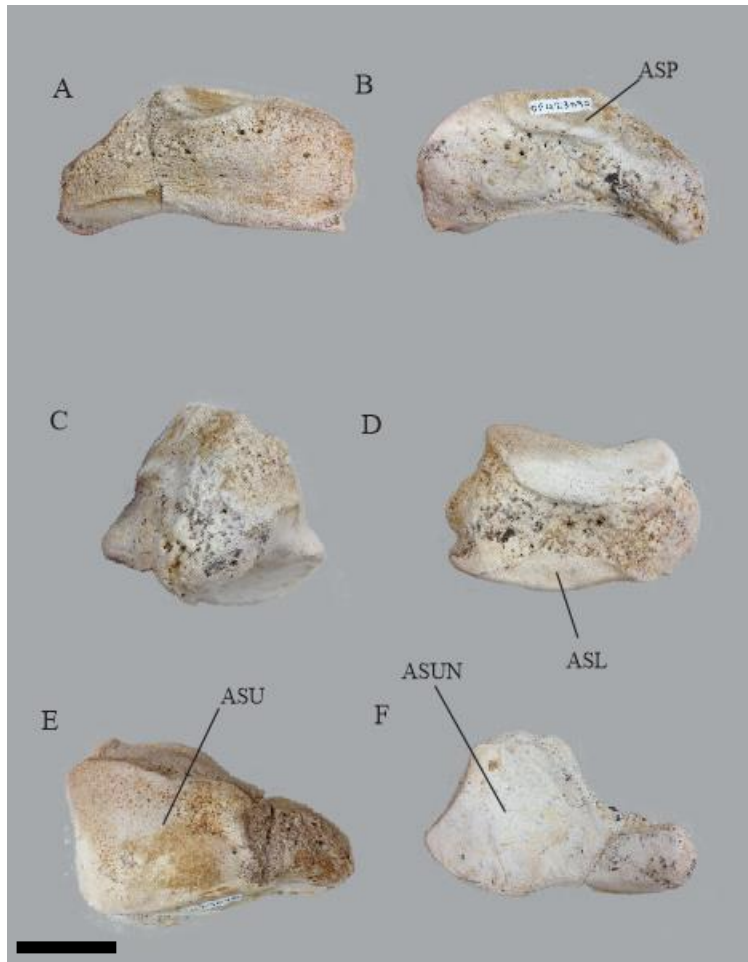


Figure 68: Right cuneiform of UF 423090.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASU, articular surface for the ulna; ASP, articular surface for the pisiform; ASL, articular surface for the lunar; ASUN, articular surface for the unciform. Scale bar = 5 cm.

Unciform. The unciform (Figure 69) articulates proximally with the cuneiform, medially with the magnum, ventromedially with the third metacarpal, distally with the fourth metacarpal, and laterally with the fifth metacarpal. Unciform is mediolaterally and anteroposteriorly elongate, and dorsoventrally shorter. Greatest mediolateral width is 93.5 mm, whereas the greatest anteroposterior length is 100.0 mm. Unciform is complete.

In dorsal view, the shape of the unciform is square. Entire dorsal surface articulates with the cuneiform (ASC2), except for the rugose anterolateral corner. There is also rugose bone posterior to the ASC2. Medial and lateral outlines are concave, with the medial side more so. Anterior and posterior outlines are undulating with the convex curvatures medially oriented and the concave curvature laterally oriented. The round rugose posterior point is centromedial located beyond the posterior outline. ASC2 surface does not have much of an arch, but the greatest doming is posteriorly oriented. ASC2 is mostly smooth anteriorly but the posterior doming is slightly porous. Articular rims are flush with the articular surfaces and the anterolateral rugose corner has two foramina.

In medial view, the unciform is trapezoidal. The longer base is the rounded posterior side and the smaller base is the slightly concave anterior side. Both the ventral and dorsal sides are concave. In the medial view, the articular surface for the magnum (ASM3) and the distal articular surface for the third metacarpal (ASMC3) are quite prominent. Dorsal edge of the proximal articular surface (ASM3), shares a conjoined facet border with ASC2's medial edge. ASM3 is long and slender. Its greatest anteroposterior length is approximately 70.5 mm and its greatest dorsoventral height is 26.0 mm. ASMC3 large, broad, and somewhat oval shaped. Dorsal articular border of the ASMC3 is raised above the articular surface. Proximal and distal articular surface connect in the middle of the unciform. Posterior area between the two articular

surfaces is concave and rugose with foramina. Anteriorly, there is a triangular section of rugose bone that is not as concave as the posterior rugose bone.

In ventral view, the unciform is very blocky. Ventral articular surface is for the fourth metacarpal (ASMC4) and is centered. Medially the ASMC3 is in view as it expands medially, and laterally, the articular surface that articulates with the fifth metacarpal (ASMC5) is also in view as it expands laterally. The three large articular surfaces give the unciform's distal surface a relatively square shape. lateral corner. ASMC4 is trapezoidal in shape with the anterior edge making the larger base and the posterior outline making the smaller base. Its greatest anteroposterior length is 67.6 mm and its greatest mediolateral width is 22.9 mm. The surface is lightly porous and darkly stained anteriorly. Posteriorly beyond the ASMC4, there is a rugose protrusion.

In lateral view, the shape is blocky and square. Anterior side is not in view due to the anterior extension of the lateral articular surfaces. Dorsal outline is convex near the ventral outline is concave. Posterior side has the large rugose protrusion. Articular surface on the lateral side is for the articulation of the fifth metacarpal (ASMC5). Main body of the articular surface encompasses the entire lateral side except for the posterior protrusion. The total ASMC5 is 74.4 mm in anteroposterior width and is 45.5 mm in dorsoventral length. The surface is proximally porous and distally smooth.

In anterior view, the bone is triangular, with the dorsal outline making the convex base and the ventral outline making the rounded point. It is very rugose, moderately flat, and has many foramina. Larger foramina are in the mediolateral center.

In posterior view, the unciform shape is triangular, with the base formed by the dorsal side and the point being the posterior rugose knot of bone. Distal of the rugose apex, the ventral outline is flat. The entire side is rugose with many foramina. There are two large foramina, one in the center, and one in the proximal medial corner. Soft tissue attachment fibers interweave around the rugose apex.

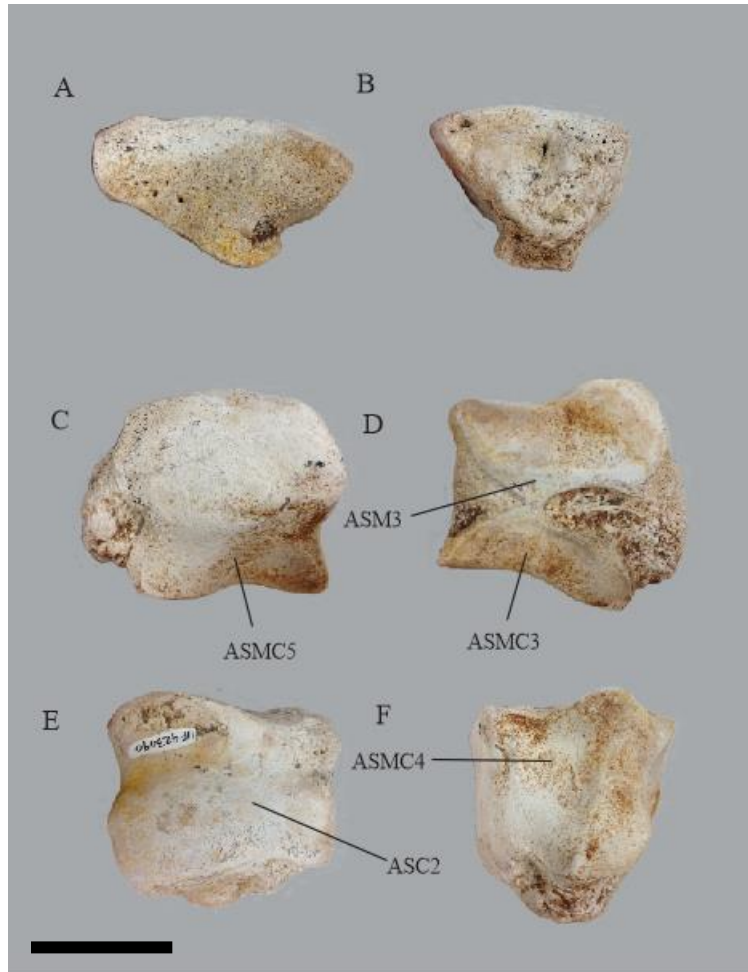


Figure 69: Right unciform of UF 423090.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASMC3, articular surface for metacarpal III; ASMC4, articular surface for metacarpal IV; ASMC5, articular surface for metacarpal V; ASM3, third articular surface for the magnum; ASC2, second articular surface for the cuneiform. Scale bar = 5 cm.

Magnum. The magnum (Figure 70) articulates proximally with the lunar, medially with the unciform, distally with the third metacarpal, and laterally with the trapezoid. Magnum is anteroposteriorly elongate and mediolaterally and dorsoventrally narrower. Greatest anteroposterior length is 98.5 mm, and the greatest mediolateral width is 75.5 mm. Overall magnum shape is square and blocky. Magnum is complete.

In dorsal view, the entire surface is comprised of the articular surface for the lunar (ASL4). ASL4 mostly flat, especially the anterior portion, but the posterior end domes greatly. Medial side of the ASL4 is mostly straight but with a central dip, and the anterior edge has an undulating curve where it starts out curved anteriorly outwards on the medial side but begins a downward descent towards the lateral side. Lateral outline is very concave and the posterior side is slightly convex from the small posterior dome, but would otherwise be moderately straight edged. Overall, the ASL4 is smooth but is porous in the anterior center, at the apex of the posterior dome, and at the posterolateral corner.

In medial view, the shape is trapezoidal, with the larger and rounded base being the posterior curvature and the anterior side comprising the smaller and slightly concave base. Ventral outline has a concave curvature, and the dorsal contour is undulating, with the convex portion posteriorly located. Proximal articular surface (ASUN2) correlates with the proximal articular surface on the unciform's medial side. The smooth ASUN2 stretches from the anterior edge to the posterior edge and is somewhat rectangular but with a proximally tapering anterior point. ASUN2's anteroposterior length is 82.7 mm and its greatest dorsoventral width is 44.2 mm. The surface is mostly smooth but is somewhat distally porous. There is no distal articular surface for the third metacarpal. Rest of the surface is rugose and concave but there is a smooth

raised band along the distal margin, which also connects with the articular surface anteriorly. Large foramina are in the central concavity.

In ventral view, the main articular surface is for the third metacarpal's proximal articular surface, also ASMC3(2), and almost entirely covers the distal surface except for some rugose posterior and medial bone that extends beyond the ASMC3(2). ASMC3(2) is 73.0 mm in greatest anteroposterior length and 59.3 mm in greatest mediolateral width. Articular surface is very smooth and dark anteriorly. Posterolaterally, a section of the articular surface curves up into the lateral side of the magnum. The shape of the magnum is rectangular. Anterior edge is slightly convex, the medial outline is slightly concave, and lateral outline is convex.

In lateral view, the shape is rectangular but with a posterior dome. Anterior side is slightly concave whereas the posterior outline is convex. Ventral outline is concave and the dorsal outline is undulating with the posterior dome becoming convex whereas the anterior is flat. There are two articular surfaces that are combined in lateral view: the proximal and anterior. Proximal articular surface articulates with the proximal articular surface on the trapezoid's medial side (ASPTD). Likewise, this same pattern corresponds with the anterior articular surface, ASATD. ASPTD's dorsal edge is flat and its posterior end is rounded. Its central margin is deeply concave, and its anterior edge is moderately flat. ASATD's edges are all relatively straight except for posterior outline which is concave anteriorly. ASPTD has an anteroposterior length of 35.8 mm and a greatest dorsoventral width of 29.9 mm. ASATD has an anteroposterior length of 47.9 mm in the center and a mediolateral width of 21.8 mm. The entire surface is smooth with no porosity. Distally, part of the ASMC3(2) has curved into the lateral side close to the posterior edge.

In anterior view, the bone is rugose, square, and flat. Foramina are scattered about, with the larger ones distally located.

In posterior view, the magnum's shape is mostly triangular. SL4 makes the base and the posteroventral apex becomes the point with the medial and lateral edges making slightly concave sides. ASL4 curves downwards into the posterior side. Apex of the ASL4 rounds out just off center on the more lateral side of the posterior surface. When the carpals are articulated, the only the posterior point of the ventral lunar surfaces covers the dorsal articulation that has curved into the posterior side. Corners of the dorsal facet are left uncovered by the lunar. Medial corner gets partially covered by the ventral cuneiform as it connects with the lunar and on the lateral side, that posterior corner gets covered by part of the scaphoid as it connects with the lunar. Beneath the ASL4 in the posterior side, the rugose bone is slightly concave, and the posterior side is mostly rugose bone, besides the ASL4. Large foramina are scattered about, and the most rugose protrusion is the most notable feature with several soft tissue attachments interweaving around it as its distally directed. Larger foramina are proximally located, and a large foramen is in the center of the proximal portion of the posterior protrusion.

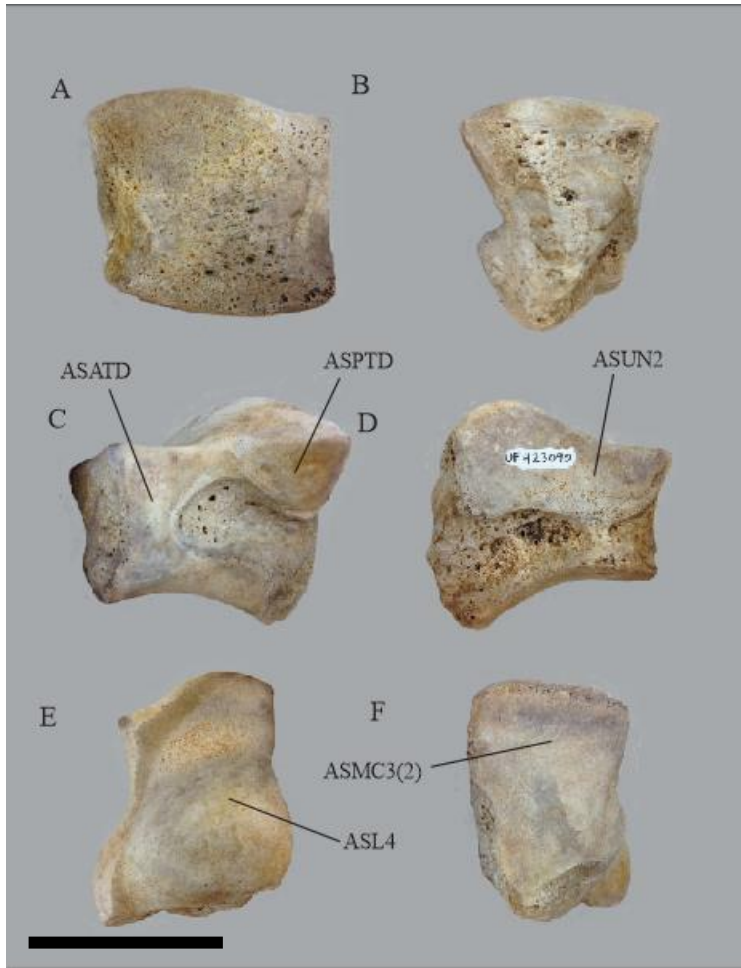


Figure 70: Right magnum of UF 423090.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASPTD, articular surface of the proximal trapezoid; ASATD, articular surface of the anterior trapezoid; ASL4, fourth articular surface of the lunar; ASMC3(2), second articular surface for metacarpal III; ASUN2, second articular surface for the unciform. Scale bar = 5 cm.

Metacarpals

Metacarpal II. The second metacarpal (MC2) (Figure 71) articulates proximally with the trapezoid, dorsomedially with the magnum, medially with the third metacarpal (MC3), and distally with the proximal phalanx for the second digit (AS2PP) and two sesamoids. As a typical metacarpal, MC2 is dorsoventrally elongate and mediolaterally and anteroposteriorly narrow. Greatest dorsoventral length is 131.0 mm; greatest mediolaterally width is 74.5 mm; and greatest anteroposterior width is 75.0 mm. MC2 is complete.

In dorsal view, the MC2 is somewhat rectangular. Anterior curvature is slightly convex and the posterior outline is also convex. Medial and lateral outlines are concave. There are two articular surfaces that have a connective border. Main articular surface (ASTD2) articulates with the trapezoid's ventral surface (ASMC2(2)). The small posteromedial articular surface (ASLM) articulates with the distal articular surface on the lateral side of the magnum (ASMC2). Connective articular margin between the two surfaces is undulatory, with a laterally convex bend posterior to the center. Anteroposterior length of ASTD2 is 70.0 mm and its central mediolateral width is 41.3 mm. Anteroposterior length of the ASLM is 39.0 mm and its central mediolateral width is 20.30 mm. The small oval ASLM is smooth and the large triangular ASTD2 is slightly porous. ASTD2 also has a osteolytic pathology along the anterior margin in the center, with smooth edges. ASTD2 is elevated above the ASLM.

In medial view, the MC2 is has concave anterior and posterior outlines. Dorsal outline is slightly convex, and the ventral outline is convexly U-shaped. Greatest concavity is seen just below the proximal articular surface (ASMC3(3)), which articulates with the proximal articular surface on the lateral side of the third metacarpal (ASMMC2). Anteroposterior length of the ASMC3(3) is 57.7 mm and its dorsoventral height is 21.3 mm. Articular rims are flush with the

depressed articular surface. Below the articular surface are two large foramina. MC2's medial side is composed of rugose bone with a few foramina visible. A small rugose nodule is in the center of the shaft and has a single foramen in it. Anteroposterior length of the ASMC3(3) is 68.5 mm and its dorsoventral height is 20.3 mm. The convex articular border is raised above the articular surface.

In ventral view, the articular surface for the proximal phalanx of the second digit is the most prominent (AS2PP) feature. Anteroposterior length of the AS2PP is about 49.4 mm and the mediolateral width is greatest at 56.5 mm. The articular surface is very circular and very distally porous. Articular border is raised above the articular surface. There is no section of smooth bone separating the AS2PP and the sesamoid surfaces.

In lateral view, there is a proximal articular surface (ASMC1(2)) that articulates with the MC1. It has a 42.3 mm anteroposterior length and a 16.8 mm dorsoventral height. Otherwise, the entire lateral side is rugose with various foramina observed. Dorsal edge is slightly convex, whereas the anterior and posterior sides are concave. Ventral curvature is convexly U-shaped. There is a proximal concave depression that stretches anteroposteriorly beneath the ASTD2, with large foramina. A rugose nodule is also located along the anterior margin in the center. Distally, the rugose bone becomes very wrinkled in appearance and has many large foramina.

In anterior view, the bone is entirely rugose. Medial and lateral outlines are proximally concave but extend distally. Ventral margin is subtly concave and the dorsal margin is greatly concave with a more proximally extended medial edge. Rest of the bone is rugose, moderately smooth and flat, and the foramina are located along the dorsal and ventral margins.

In posterior view, there is a large rugose protrusion extending from the center of the proximal edge. Few foramina are visible in the rest of the concave rugose body, but there is a rugose nodule on the medial side with a large foramen. Distal medial and lateral sesamoid surfaces are the most prominent features. Medial sesamoid is 43.6 mm in dorsoventral height, and its mediolateral width is 26.8 mm. Lateral sesamoid is 32.4 mm in dorsoventral height, and its mediolateral width is 32.6 mm. A ridge separates the two surfaces.

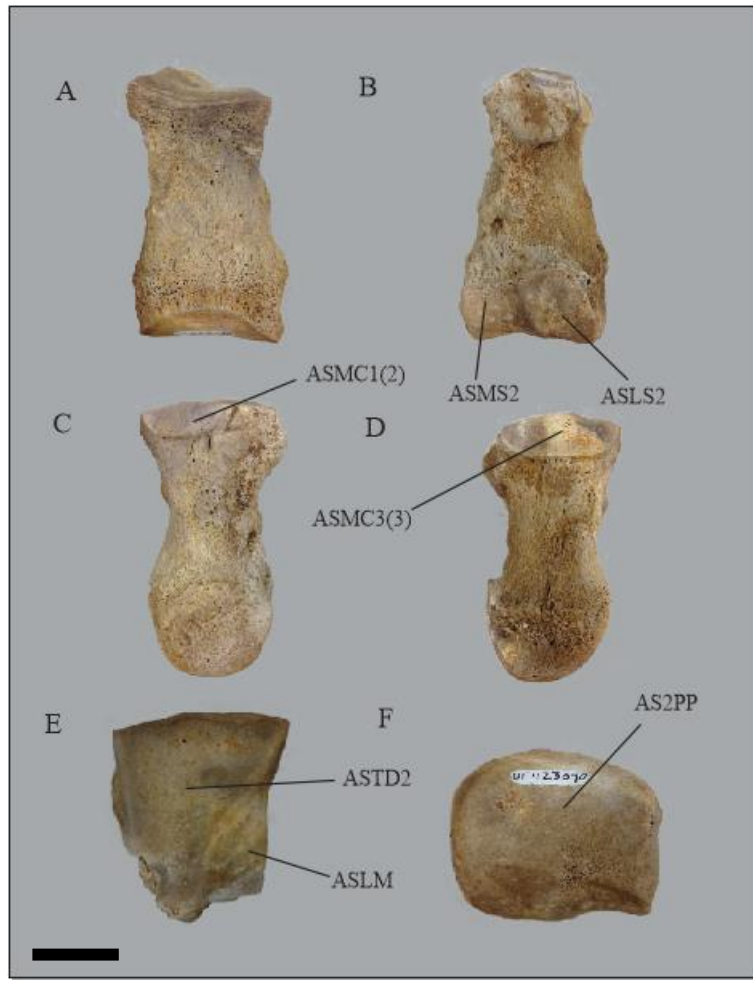


Figure 71: Right metacarpal of UF 423090.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASMS2, articular surface for the medial sesamoid of digit II; ASLS2, articular surface for the lateral sesamoid of digit II; ASMC1(2), second articular surface for metacarpal I; ASMC3(3), third articular surface for metacarpal III; ASLM, articular surface for the lateral side of the magnum; ASTD2, second articular surface for the trapezoid; AS2PP, articular surface for the proximal phalanx of digit II. Scale bar = 5 cm.

Metacarpal III. The third metacarpal (MC3) (Figure 72) is the largest metacarpal and it articulates proximally with the magnum, dorsomedially with the unciform, medially with the second metacarpal, laterally with the fourth metacarpal, and distally with the proximal phalanx for the third digit and two sesamoids. It's dorsoventrally elongate and mediolaterally and anteroposteriorly narrow. Its greatest dorsoventral length is 147.0 mm; its greatest mediolateral width is 76.5 mm; and its greatest anteroposterior width is 81.0 mm. MC3 is complete.

In dorsal view, the shape is very triangular with the anterior edge making the base and the rounded posterior making the point. Medial and lateral outlines are convex. Two articular surfaces encompass the dorsal surface. The first, and more central, is the articular surface for the magnum (ASM4), which articulates with the magnum's distal surface (ASMC3(2)). Its anteroposteriorly 76.8 mm long, and has a mediolateral width of 45.7 mm. The other dorsal articular surface connects dorsomedially with the unciform (ASUN4), articulating with the distal articular surface on the unciform's medial side (ASMC3). Its anteroposterior length is 71.0 mm and it is mediolaterally 23.2 mm wide. ASM4 is larger than the ASMC3 and both surfaces share a conjoined border, which starts at the center of the posterior corner and cuts to the anteromedial corner. The connective margin is the highest point of the MC3. ASM4 is triangular whereas the ASMC3 is more oval or roundly rectangular. The surfaces are mostly smooth with porous edges, but the shared border is also mostly smooth.

In medial view, the anterior and posterior sides are concave, with the posterior outline more so. Both the dorsal and ventral curvatures are convex. Most of the bone is rugose, but there is a large proximal articular surface (ASMC2(3)), which articulates with the MC2. ASMC2(3) is oval and narrows posteriorly. It has an anteroposterior length of 58.05 mm and a dorsoventral

height of 25.0 mm. The surface is slightly porous. Rest of the bone is rugose with no nodules or ridges and bone beneath the articular surface is concave.

In ventral view, the main feature is the articular surface for the proximal phalanx (AS3PP) associated with digit III. It is large, circular, and mostly smooth with anterior porousness. There is no space between the AS3PP and the sesamoids surfaces. Its anteroposterior length is 40.3 mm and the mediolateral width between the AS3PP and sesamoid surfaces is 62.9 mm. The greatest anteroposterior length of the AS3PP 56.1 mm, and the greatest width is about 74.5 mm.

In lateral view, the anterior and posterior curvatures are concave whereas the dorsal and ventral outlines are convex. Most of the lateral bone is rugose but there is a proximal articular surface, which articulates with the fourth metacarpal (ASMC4(2)). This articular surface is a large oval and narrows posteriorly. It is at least 56.6 mm in anteroposterior length and has a greatest dorsoventral height of 21.9 mm. This surface is porous and the distal articular border is raised above the articular surface. The rest of the rugose bone is concave beneath the articular surface with large foramina, and its most concave beneath the articular surface. A small rugose ridge is anteriorly located beneath the articular surface and borders the deep concavity.

In anterior view, the dorsal outline comes to a triangular point that is more medially oriented where the two dorsal articular surfaces connect. Lateral and medial outlines of the bone are straight once they have concavely curved beneath the proximal articular surfaces on their respective sides. Many foramina are located along the dorsal and ventral margins. AS3PP curves up into the anterior plane with its convex apex centrally located. The surface is mostly flatly and smoothly rugose with a small dorsomedial nodule extending outwards.

In posterior view, the MC3 is moderately symmetrical and it gradually narrows proximally. There is a large rugose proximal protrusion that is medially oriented and the MC3 body becomes concave beneath it before extending back out to the sesamoid surfaces. The rugose bone does not have many foramina or soft tissue attachment fibers, but there is a rugose ridge along the lateral outline. Distally, the two sesamoids surfaces have a bifurcated ridge almost symmetrically between them. ASMS3 is 40.5 mm dorsoventrally long and 31.9 mm mediolaterally wide. ASLS3 is at least 38.2 mm in dorsoventral length and is 28.6 mm mediolaterally wide. The surfaces are mostly smooth and proximally porous. The bifurcated ridge is not porous.

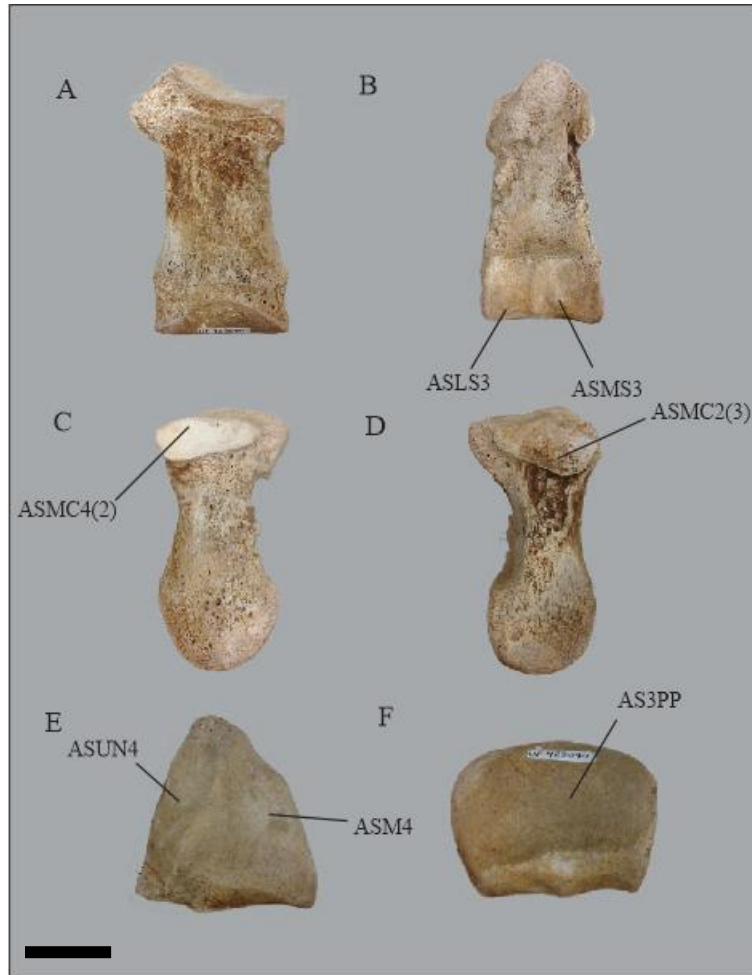


Figure 72: Right metacarpal III of UF 423090.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASLS3, articular surface of the lateral sesamoid of digit III; ASMS3, articular surface of the medial sesamoid of digit III; ASMC2(3), third articular surface for metacarpal II; ASMC4(2), second articular surface for metacarpal IV; ASUN4, fourth articular surface for the unciform; ASM4, fourth articular surface for the magnum; AS3PP, articular surface for the proximal phalanx of digit III. Scale bar = 5 cm.

Phalanges

Proximal Phalanges

Proximal Phalanx Digit III. The proximal phalanx for digit III (PP3) (Figure 73) articulates proximally with the distal surface of Metacarpal III and distally with the proximal surface of the medial phalanx for digit III. It is dorsoventrally and mediolaterally elongate and anteroposteriorly narrow. Its greatest dorsoventral length is 75.0 mm; its mediolateral width is 78.0 mm; and its greatest anteroposterior width is 48.5 mm. PP3 is complete.

In dorsal view, the entire surface is comprised of the articular surface that articulates with the distal articular surface of the third metacarpal (ASDMC3). This flat articular surface is about 67.9 mm in mediolateral width and 44.1 mm in greatest anteroposterior length. Overall shape is symmetrically oval. The anterior half is smooth, but the posterior half is porous and lighter in color. Articular borders are flush with the articular surface.

In medial view, the bone is rugose. Posterior curvature is deeply concave, but the anterior outline is hardly concave, and mostly straight. Ventral outline has the typical U-shape convex curvature and the dorsal outline is flat. The medial side itself has a central concave channel but the distal U-shaped bone extends outwards medially, and the proximal bone extends medially more so with a rugose protrusion or nodule of bone. Small foramina are scattered about.

In ventral view, the articular surface that articulates with the proximal articular surface on the medial phalanx for the digit III is the prominent feature (ASPMP3). This surface is an oblong, symmetrical oval. It is about 56.1 mm in mediolateral width and is 27.4 mm in anteroposterior length. Most of the surface is smooth distally and porous anteriorly. Anterior articular rim is raised above the articular surface.

In lateral view, the rugose bone symmetrically mirrors the bone's medial side. The outlines, proximal and distal extensions, central channel, and soft tissue attachments are all similar.

In anterior view, PP3 is very rugose and symmetrical. Both the medial and lateral outlines display a central channel running between proximal and distal extensions in the bone. These medial proximal and distal extensions project medially outwards to roughly the same extent. Dorsal outline is convex, and the ventral outline is subtly concave, almost straight. Anterior side itself is almost straight with only a small concave curvature in the center. There is a ridge of bone spanning the mediolateral width proximally. ASPMP3 curves into the anterior side with an upwardly convex curvature, with its apex centrally located. Some small foramina are scattered throughout the surface and two large ones are centrally located side by side.

In posterior view, the two most notable features are the cartilaginous surface and the cyst features. Distally, there is an upwardly convex surface that is smooth. The surface does not appear to be an articular one, but rather a cartilaginous one with a 58.3 mm mediolateral width and a 27.1 mm dorsoventral height. There is no cleft or dip in the cartilaginous surface. Above the distal surface, there are three large osseous cyst-like lesions. The larger lesional pocket is directly centered above the cartilage surface but is moderately shallow. There is a cyst pathology on the medial and lateral side of the large central one. Each is shallow. Dorsally, there is a wide band of rugose bone stretching the entire mediolateral width and curving into the proximal medial and lateral sides. In the center of the rugose band, the bone is concave with a central convex apex, giving the rugose band an M-shape in its distal center. A single foramen borders each side of the M-curvature.

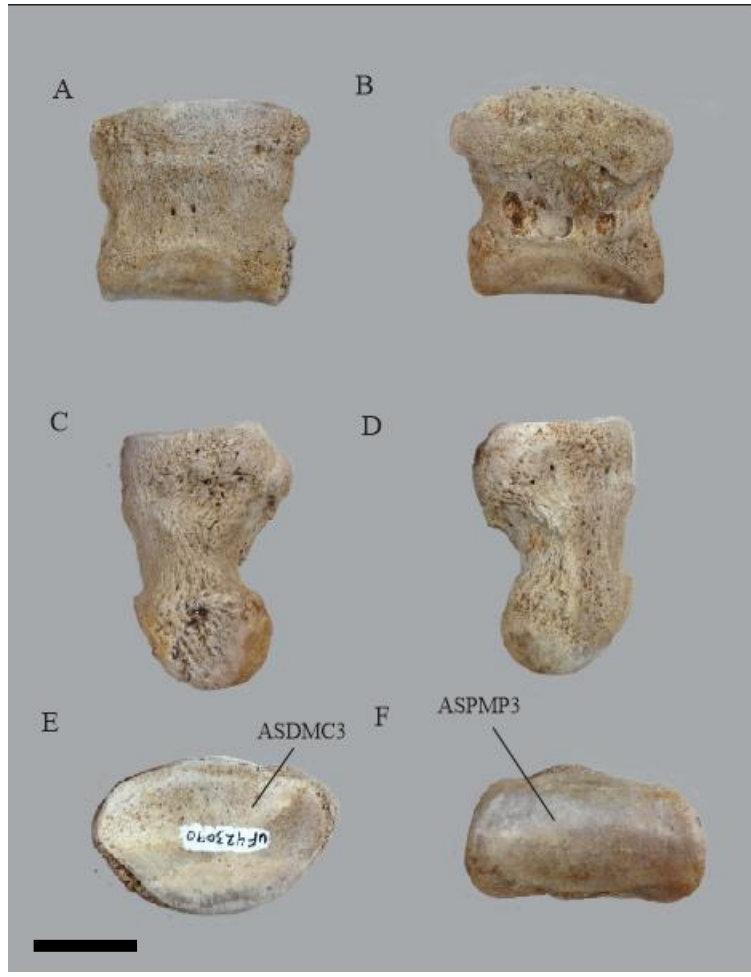


Figure 73: Right proximal phalanx of digit III of UF 423090. A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASPMP3, articular surface to the proximal surface of the medial phalanx of digit III; ASDMC3, articular surface to the distal surface of metacarpal III. Scale bar = 5 cm.

CHAPTER 7. *Mammuthus columbi* FROM HARRISON RANCH SITE

Left Manus

The Columbian mammoth, *Mammuthus columbi* (UF 256400) has left manus carpals, metacarpals, phalanges, and sesamoids.

Carpals

Pisiform. The pisiform (Figure 74) connects with the cuneiform by a proximally oriented articular surface on the medial side of the bone and with the ulna by an articular facet on the dorsal surface. Overall, the bone is pinched mediolaterally and tapers to a ventral tip. Its greatest dorsoventral length is 167.0 mm and its greatest anteroposterior width is 72.0 mm. Pisiform is almost complete with some chipping.

In dorsal view, the articular surface for the ulna (ASU3) is oval shaped and has some chipped posterior surface. Articular surface is slightly porous. Anterior end does not appear narrow from the rest of the articular surface. ASU3's medial border that it shares with the medial side's articular surface for the cuneiform (ASC4) is chipped, but it appears that there is a depressed connection between the two articular surfaces. ASU3'S medial border is the ASC4's dorsal border. Overall shape of the dorsal pisiform is oval. Rugose bone is visible both posteriorly and anteriorly beyond the ASU3. Its greatest anteroposterior length is 59.6 mm and its greatest mediolateral width is 30.1 mm.

In medial view, the pisiform is anteriorly curved, though not greatly so. Dorsal margin is flat; the posterior outline is convex; ventral margin is convexly rounded distally; and the anterior margin is concave. Proximal articular surface, ASC4, is flat dorsally and the rest of the border is a single large distally convex curvature that is posteriorly directed. Anteroposterior length is 51.3

mm and its dorsoventral width is 58.7 mm. The surface is smooth, flat, and the articular border is flush with the surface. The rest of the bone on the medial side is rugose. There is also a rugose ridge of bone running from the proximal posterior corner and across to the anterior side, and the distal bone is extended in a large circular nodule. The bone is concave in the center between these two features. Various sized foramina are scattered throughout the rest of the surface.

In ventral view, the rugose tip of the pisiform is all that is viewable. There are no foramina and the rugose surface is smooth.

In lateral view, bone is entirely rugose and has the same shape as the medial side. There are no ridges or nodules but the center of the surface is rugosely wrinkled with two very large foramina. There are also several dorsoventrally oriented soft tissue attachment fibers. The rugose surface is smoother beneath the middle scarring.

In anterior view, the bone is entirely rugose and concavely curved. The center is concave whereas the proximal and distal ends are anteriorly extended. Within the greater concavity, the rugose bone is smoother than the surrounding rugose bone. Distal tip of the pisiform is also more medially oriented. Several small foramina are scattered about, but not within the central smooth rugose concavity.

In posterior view, the whole surface is rugose and riddled with foramina. Every outline is convex except for the inward dip beneath the medial side's proximal articular surface. There is also a long dorsoventral ridge that runs down the center of the posterior surface with mediolateral soft tissue fibrous scarring.

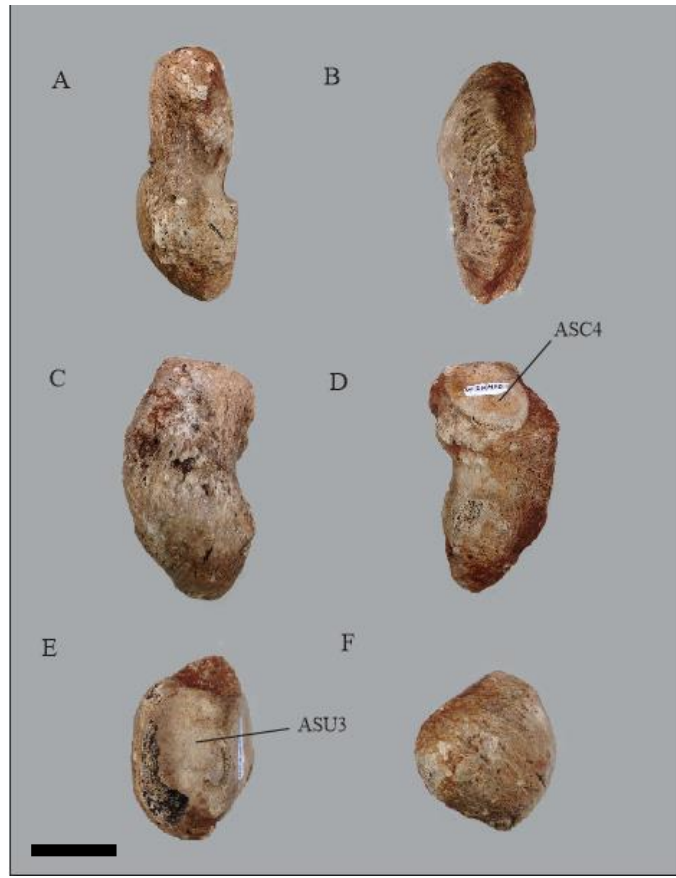


Figure 74: Left pisiform of UF 256400.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASU3, third articular surface for the ulna; ASC4, fourth articular surface for the cuneiform. Scale bar = 5 cm.

Cuneiform. The cuneiform (Figure 75) articulates proximally with the ulna, distally with the unciform, medially with the lunar, and posteriorly with the pisiform. Anteroposterior and mediolateral axes are long whereas the dorsoventral axis is short in comparison. Cuneiform's greatest mediolateral width is 155.0 mm, and the greatest anteroposterior width is 149.0 mm. Cuneiform is almost entirely complete but has several chipped surfaces.

In dorsal view, the cuneiform is triangular shaped with the medial edge forming the base and the lateral projection tapering to the point. Anterior side is convex, as is the medial side. Posterior outline is concave but the articular surface for the ulna (ASU) extends over the concave curvature. Posterior ASU margin is convex. Lateral projection is short, posteriorly curved, and is lateral convex. Most of the dorsal surface is the ASU, which laterally terminates as the rugose section of the lateral projection begins. Shape of the ASU is triangular, with the base being the cuneiform's medial side, and lateral rounded end is the point. Anterior and posterior sides are convex, with the anterior side more so. ASU shares an articular edge with the articular surface for the pisiform (ASP) that is on the posterior side. ASU is concave and smooth, except for anterolateral section that is roughly textured and darkly colored. Greatest mediolateral width of the ASU is 96.0 mm, and greatest anteroposterior length of the ASU is about 121.4 mm. ASP is not in view and there is a posteromedial rugose nodule that is nearly as extended as the rugose lateral projection.

In medial view, both the dorsal curvature is concave and the ventral outline is concave in the center and convex at the posterior and anterior margins. Both the posterior and anterior outlines are convex. Anterior and posterior sides are equal in thickness. ASU curves downwards into the cuneiform's medial side but that surface is badly chipped. Medial side has a posteroventral articular surface for the lunar (ASL) that is also badly chipped, but it is on the

anterior side and looks like it terminates in the center of the dorsal margin. What is left of the ASL appears smooth and the rest of the bone is concave and rugose, riddled with foramina.

In ventral view, the entire surface is the articular surface for the unciform (ASUN). Anterior margin is mostly convex but has a central inward depression and the posterior margin is strongly concave. Medial side is also concave but the central chipping could be the cause. and the short lateral projection convexly rounds out and points posteriorly. Most of the central surface is smooth but the lateral projection is rougher, and the edges are slightly porous.

In lateral view, most of what is visible is the rugose tip of the lateral projection. It is greatly posteriorly curved and is riddled with foramina.

In anterior view, the ASUN edge is flat before concavely curving with the lateral projection, and the ASU edge has an undulating contour. The entire anterior surface is rugose with foramina along the dorsal and ventral margins. Soft tissue attachments fibers run mediolaterally up until the lateral projection. ASU does not curve onto the anterior side but the ASUN does, curving upwards and wrapping anteriorly around the lateral projection.

In posterior view, the ASP is triangular and tapers dorsolaterally. Shared ASU border is flat and the rest of the articular border is distally convex, narrowing along the lateral projection. ASP is flat. Greatest mediolateral width for the ASP is 54.9 mm and its greatest dorsoventral length, laterally oriented, is 64.3 mm. Beneath the facet for the pisiform, the rugose bone is only slightly concave and has several foramina. The rest of the bone is rugose but with little foramina. Remaining rugose bone is moderately smooth with soft tissue attachment fibers. Along the lateral projection, the fibers run from the tip and towards the ASP. Beneath the ASP, these fibers run dorsoventrally. There is also a large rugose nodule on the medial side.

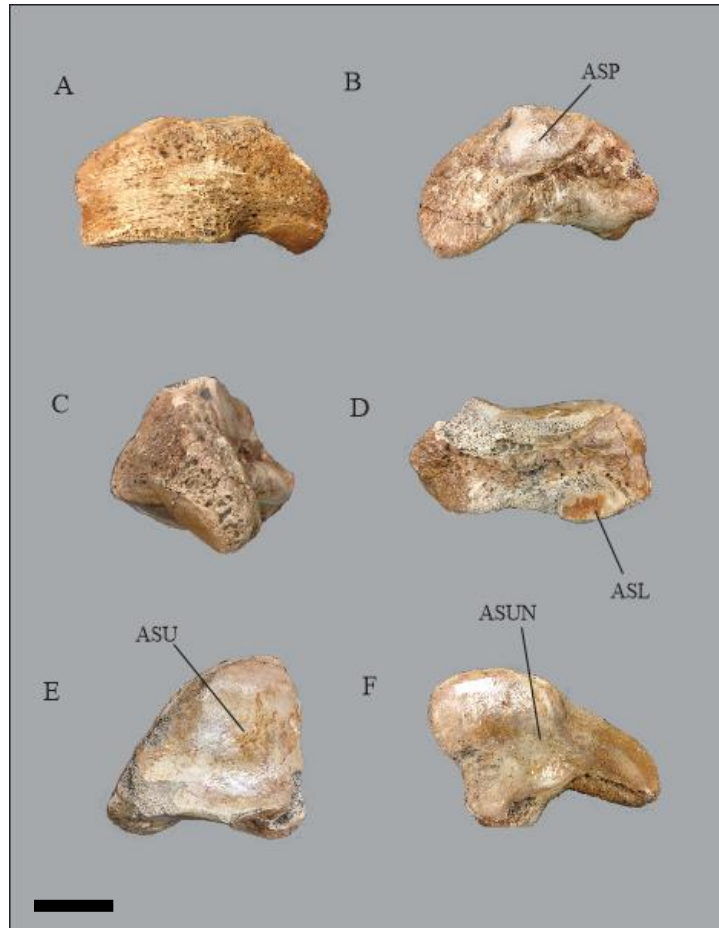


Figure 75: Left cuneiform of UF 256400.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASP, articular surface for the pisiform; ASL, articular surface for the lunar; ASU, articular surface for the ulna; ASUN, articular surface for the unciform. Scale bar = 5 cm.

Lunar. The lunar (Figure 76) articulates proximally with the radius, dorsomedially with the ulna, medially with the cuneiform, distally with the magnum, and laterally with the scaphoid. Lunar is anteroposteriorly elongate with the anterior mediolateral length nearly matching the anteroposteriorly length, but the mediolateral length narrows significantly towards the posterior extremity. Lunar is dorsoventrally short. Greatest anteroposterior length is 149.0 mm and the greatest mediolateral width is 149.0 mm. Lunar is complete.

In dorsal view, the bone is triangular, and looks much like a bike seat in shape. Anterior side is convex whereas the medial and lateral sides are concave. Posterior curvature is also convex, with some rugose bone posteromedially extending beyond the articular surface. The entire surface is the articular surface for the distal radius (ASR). ASR is very smooth and there are several osteolytic features centrally located. Four holes are easily apparent and there are about 5 pin prick tiny holes forming as well. Along the edges, there is some slight porosity and the posterior side is darkly colored with more porosity observed. No medial or lateral surfaces extend beyond the margins in dorsal view.

In medial view, there are two articular surfaces: the proximal ASU2 and the distal articular surface for the cuneiform (ASC). ASU2 is very circular, slightly porous, and distally chipped. ASU2 has an anteroposterior length of 41.4 mm and a dorsoventral width of 23.0 mm. There appears to be a large but shallow osteolytic pathology starting in the center. Distal ASC is oval and the entire surface is worn off. ASC has an anteroposterior length of 58.3 mm and a dorsoventral width of 27.0 mm. The rest of the bone is rugose and is concave between the articular surfaces. There is an anterior ridge of bone that extends medially and the posterior tip is a rugose knot. Large foramina are in the central cavity beneath the ASU2 and smaller foramina are throughout the rest of the rugose surfaces. Anterior side is convex distally and concave

proximally and the posterior margin is entirely convex but more distally extended. Dorsal and ventral margins are concave posteriorly and convex anteriorly.

In ventral view, the articular surface for the magnum (ASM) takes up the entirety of the bone surface but is greatly chipped along the lateral side. It is greatly concave from the posterior point up to where the facets appear on the lunar's medial and lateral sides, which is where the rest of the bone up to the anterior side becomes convex. The bone is triangular with a flat anterior side, a concave medial side, and a convex lateral and posterior outline. ASM's anterior is smooth whereas the posterior is porous. There are three large osteolytic feature in the center and several small ones starting in the center and along the medial margin. The posterior point is medially directed.

In lateral view, the overall shape is triangular with the anterior side forming the base and the posterior outline making the point. Anterior side is flat proximally and concave distally. Dorsal margin is mostly flat but curves proximally to the anterior edge. Ventral surface is concave posteriorly and convex anteriorly. Posterior side is a convexly rounded rugose knot. There are two articular surfaces: the ventral articular surface for the scaphoid (VASS) and the dorsal articular surface for the scaphoid (DASS). Posterior DASS is oval shaped and narrows anteriorly. It is anteroposteriorly 75.6 mm long and about 31.9 mm in dorsoventral height. VASS is oval and located anteriorly. It is about 38.0 mm long anteroposteriorly and has a greatest dorsoventral height of 19.1 mm. Both surfaces are smooth. DASS has a raised circular center whereas the tapering anterior is dark and depressed. The rest of the bone is rugose, slightly concave, and has many large foramina posteriorly located. A circular concavity is also located posterior to the VASS and has a few foramina at its concave apex.

In anterior view, the anterior side is trapezoidal. The lateral side is thicker than the medial side, making the larger base. Undulating dorsal outline is convex laterally and concave medially. Concave ventral margin is more distally extended laterally. ASR does not curve into the anterior side, making the entire surface rugose. A large rugose band extends from the center of the lateral side and curves across and down to the distal medial side. Foramina distally border this band and small foramina are located along the proximal section of the rugose band. Soft tissue attachment scarring follows the direction of the mediolateral band.

In posterior view, the point is very rugose, though smoothly so with dorsomedial fibrous scarring, and the foramina are located above the posterior knob. Medial and lateral side are viewable as they extend beyond the posterior protrusion.

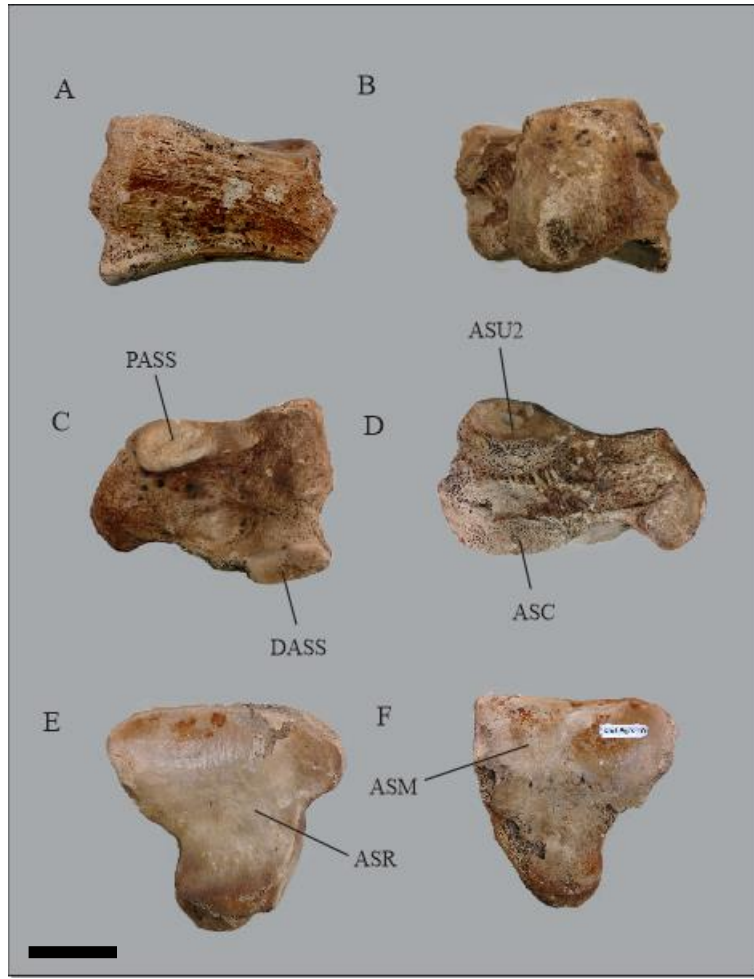


Figure 76: Left lunar of UF 256400.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. PASS, proximal articular surface for the scaphoid; DASS, distal articular surface for the scaphoid; ASU2, second articular surface for the ulna; ASC, articular surface for the cuneiform; ASR, articular surface for the radius; ASM, articular surface for the magnum. Scale bar = 5 cm.

Scaphoid. The scaphoid articulates proximally with the radius, laterally with the lunar, and distally with the magnum, trapezoid, and trapezium. It is dorsoventrally and anteroposteriorly elongate but narrow mediolaterally; however, this scaphoid split into two separate bones, a proximal half and the distal base. Proximal scaphoid (Figure 77) has a greatest dorsoventral length of 129.0 mm; a greatest anteroposterior length of 112.0 mm; and a greatest mediolateral width of 70.0 mm. Distal scaphoid base (Figure 78) has a greatest dorsoventral length of 64.0 mm; a greatest anteroposterior length of 67.0 mm; and a greatest mediolateral width of 129.0 mm. Both bones are complete but has some chipping on articular surfaces.

In dorsal view of the proximal scaphoid bone, the circular ASR2 is the most prominent observable feature, though some of the concave posterior edge is visible around ASR2. Dorsal articular surface for the radius has a conjoined rim that connects with the proximal articular surface on the scaphoid's medial side, which articulates with the proximal articular surface on the lunar's lateral side. This conjoined articular surface is ASL3. ASR2 is smooth without any noted porousness, and the center of the articular surface has a subtle raised ridge. Much of the articular border is elevated above the articular surface. Greatest anteroposterior length of the ASR2 is roughly 68.1 mm and its greatest mediolateral width is 49.0 mm.

In dorsal view of the distal scaphoid bone, the articular surface for the distal articular surface of the proximal scaphoid bone (ASDPS) is prominent. Bone's overall shape is oval with a medial extended triangular rugose point, and all the bone rimming the articular surface is rugose. Articular surface is also oval but has a deep central dip along the medial margin where foramina are clustered. The surface is smooth, and the articular borders are raised above the articular surface. Three small nodules are on the posterolateral rim and two small osteolytic features are anteriorly located within the articular surface. Articular surface has an

anteroposterior length of 86.0 mm and a greatest mediolateral width of 37.11 and a central mediolateral width of 22.8 mm.

In medial view for the proximal scaphoid bone, only one articular surface is present: the proximal ASL3. Articular surface is very oval with an anteroposterior length of 44.5 mm and a dorsoventral width of 30.1 mm. The surface is smooth and darker in the center. Most of the articular surface is flush with the border, but there is also chipping along the rims. The rest of the bone is rugose and concave with a central ridge running dorsoventrally. Soft tissue attachment fibers are mediolateral along the ridge. Posterior outline is concave, and the anterior outline is convex. The dorsal and ventral outlines are also subtly convex.

In medial view for the distal scaphoid bone, has a distal articular surface for the lunar, ASL2, which is oval and smooth. Part of the ASMTDTM also curves proximally, sitting beside the ASL2. Anteroposterior width is about 43.8 mm and has a dorsoventral width of 28.6 mm. Bone above the articular surfaces are concave and rugose with many foramina. Greatest concavity is just above the ASL2.

In ventral view for the proximal scaphoid bone, there is an articular surface that articulates with the proximal surface of the distal scaphoid bone. The bone is oval but has a deep central dip with a large foramina in its center. Articular surface has an anteroposterior length of 83.3 mm and the greatest mediolateral width is 35.6 mm. Central mediolateral width is 23.4 mm. The surface is smooth and flush with the articular borders. Surrounding bone is rugose and there is a medial extension in the center of the medial side. Foramina are scattered in the rugose bone.

In ventral view for the distal scaphoid bone, the ASMTDTM is most prominent and is a long oval. ASMTDTM has its greatest anteroposterior length at 108.2 mm and its greatest

mediolateral width at 72.3 mm. Articular surface is very smooth but much of the surface is worn and chipped away. Articular borders are flush with the surface.

In lateral view for both scaphoid bones, the entire surface of bone is rugose and many foramina are observable. There are no ridges or nodules. Most of the soft tissue scars run mediolaterally, but at the joined margins of the two scaphoid bones, the soft tissue attachment fibers run dorsoventrally. Larger foramina are close to the connective margins of the two bones.

In anterior view for both the combined proximal and distal scaphoid bones (Figure 79), the rounded anterior edge is all that comprises the scaphoid's anterior side. Foramina are scattered about, more towards the lateral side. Soft tissue attachment fibers run mediolaterally.

In posterior view, a large, concavely curved edge between the lateral and medial sides is all that is present. There is a rugose proximal nodule that extends medially. Most of the rugose bone is smoothly wrinkled, and the foramina are located towards the lateral side.

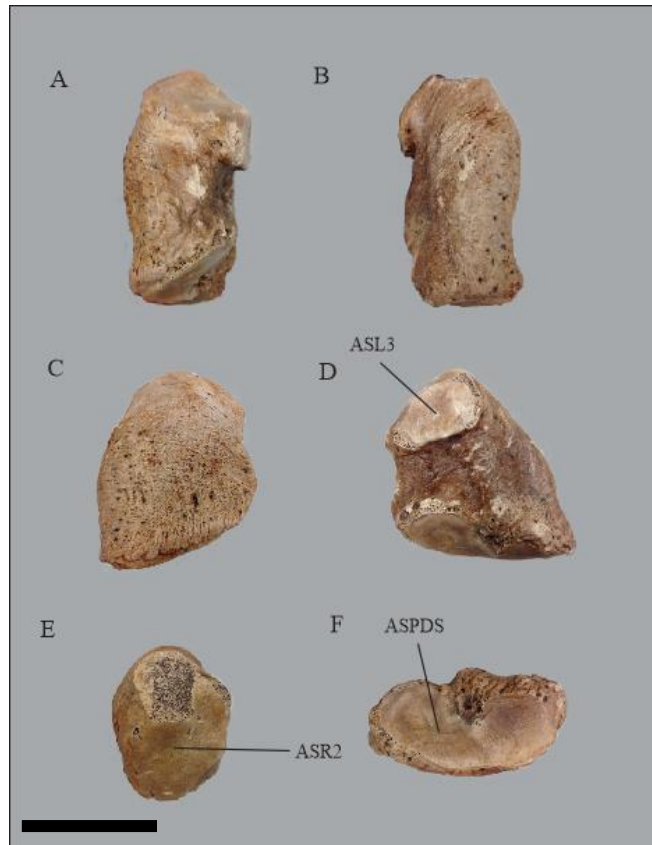


Figure 77: Left proximal scaphoid of UF 256400.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASL3, third articular surface for the lunar; ASPDS, articular surface for the proximal surface of the distal scaphoid; ASR2, second articular surface for the radius. Scale bar = 5 cm.

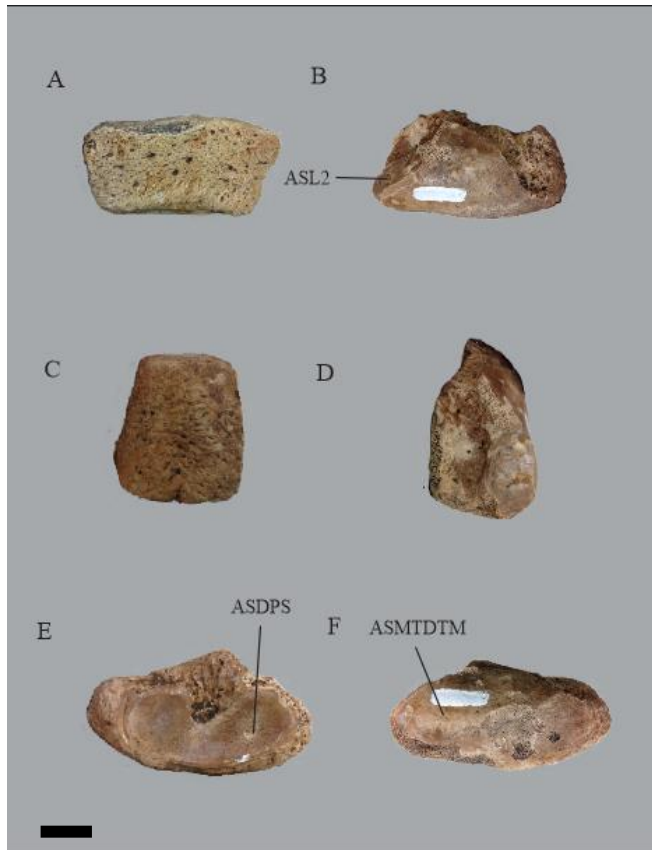


Figure 78: Left distal scaphoid of UF 256400.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASL2, second articular surface for the lunar; ASDPS, articular surface for the distal surface of the proximal scaphoid; ASMTDTM, articular surface for the magnum, trapezoid, and trapezium. Scale bar = 5 cm.



Figure 79: Left proximal and distal combined scaphoids of UF 256400. A, anterior; B, posterior. Scale bar = 5 cm.

Unciform. The unciform (Figure 80) articulates proximally with the cuneiform, medially with the magnum, ventromedially with the third metacarpal, distally with the fourth metacarpal, and laterally with the fifth metacarpal. Unciform is mediolaterally and anteroposteriorly elongate, and dorsoventrally shorter. Greatest mediolateral width is 131.0 mm, whereas the greatest anteroposterior length is 148.0 mm. Unciform is complete but has some cortical weathering.

In dorsal view, the shape of the unciform is trapezoidal. Anterior margin is mostly convex but with a slight central dip that could be caused by chipping, and the posterior, lateral, and medial margins are convex. Lateral margin is almost straight however, and the posterior margin has only the slightest concavity with a central depression. The entire dorsal surface is the articulated surface for the cuneiform (ASC2). ASC2 is mostly smooth and concave.

In medial view, the unciform is trapezoidal. The longer base is the rounded posterior side with its large rugose protrusion and the smaller base is the convex anterior side. Ventral and dorsal sides are concave. Both the dorsal and ventral outlines have their greatest concavities anteriorly. In the medial view, the articular surface for the magnum (ASM3) is most prominent and there is also a small distal articular surface for the distal articular surface on the medial side of the magnum (ASM5) and the articular surface for the third metacarpal (ASMC3) is located beneath it. Dorsal edge of the proximal articular surface (ASM3), shares a conjoined facet border with ASC2's medial edge. ASM3 is long, broad, and flat with a slight concave ventral edge. Its greatest dorsoventral height is 48.9 mm on the posterior end whereas its minimal dorsoventral height, in the central area, is about 36.7 mm. Its anteroposterior length is 113.5 mm. Much of the ASM5 is chipped but its approximate anteroposterior length is 62.1 mm and its greatest dorsoventral height is about 15.6 mm. ASM3 is smooth and has a distal anterior ridge that is

raised. Surface between the ridge and the distal margin is depressed. The rest of the bone between the two surfaces is rugose and concave with several foramina in the center.

In ventral view, the unciform is very triangular, with the anterior side making the base and the posterior end comprising the point. Anterior curvature is not entirely in view since the ASMC4 extends of the rim. Medial side is slightly concave whereas the lateral side is slightly convex. There are three articular facets on the ventral side: the medial ASMC3, the central articular surface is for the fourth metacarpal (ASMC4), and the lateral articular surface that articulates with the fifth metacarpal (ASMC5). Anteroposterior length of the ASMC3 is 94.3 mm and its greatest mediolateral width is 34.9. This articular surface has a raised center with an anteroposterior length of 66.9 mm and is 28.3 mm mediolateral wide. Anteroposterior length of the ASMC4 is 97.3 mm and its central mediolateral width is 56.6 mm. Anteroposterior length of the ASMC5 is 88.0 mm and its central mediolateral width is 59.2 mm. Its raised center has an anteroposterior length of 80.0 mm and a mediolateral width of 55.0 mm.

The ASMC3 is roughly rectangular shaped and slants proximal towards the medial side. It is porous, although the raised center is smoother. ASMC4 is trapezoidal in shape, with the posterior edge making the smaller base and the slanted anterior side making the larger one. Anteromedial section is mostly flat whereas the anterolateral section of this articular surface anterior extends and has a convex curvature. Its straight shared borders with the ASMC3 and ASMC5 make the sides. This surface is smooth. ASMC4 is rectangular and smooth on the ventral side but greatly extends into the lateral side. In its depressed posteromedial corner, there are two large osteolytic features.

In lateral view, the ASMC5 extends from the ventral side and stretches proximally to connect with the dorsal margin. It is a slanted rectangular band that crosses from the distal

anterolateral corner to the proximal posterolateral corner. It has a raised circular surface with an anteriorly located osteolytic pathology. Most of the ASMC5 is smooth but the texture becomes rough distally on the ventral side.

In anterior view, the bone is trapezoidal with the thicker medial side making the larger base and the ventral side making the smaller one. Both sides are convex, more so proximally. This side is entirely rugose and has many proximal foramina. There is a rugose ridge in the center along the lateral side that terminates before it reaches the middle of the anterior surface. Soft tissue fibrous attachments run mediolaterally along it.

In posterior view, the unciform shape is triangular, with the base formed by the dorsal side and the point being the distal rugose posterior knot of bone that points to the medial side. The entire side is rugose and large foramina are along the dorsal margin. Soft tissue attachment fibers run mediolateral proximally and are dorsoventral in the knot.

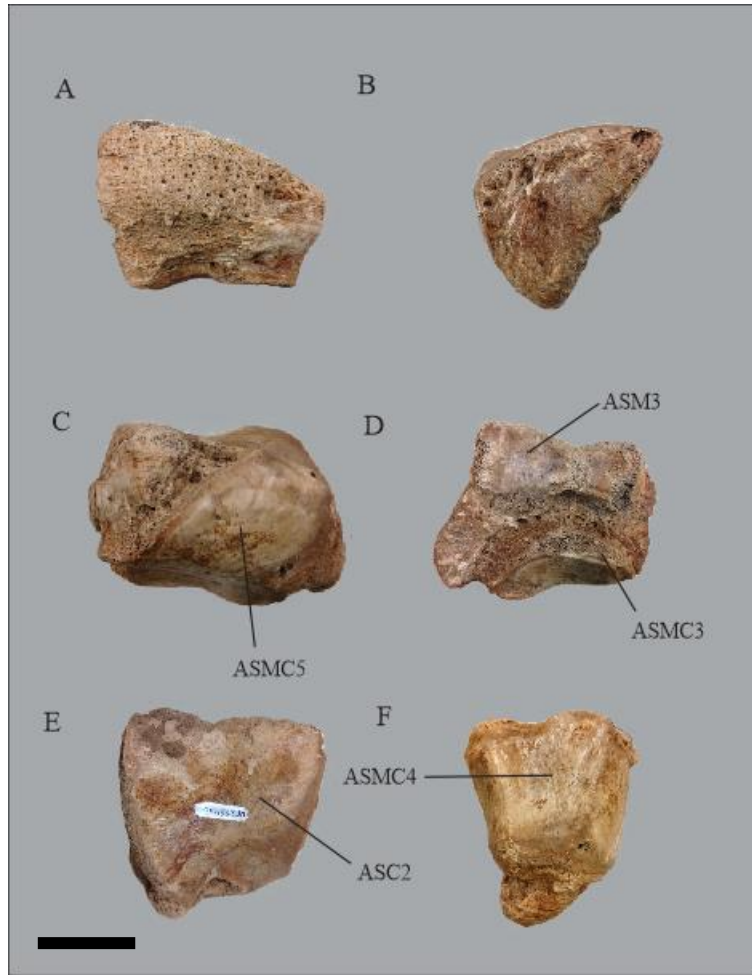


Figure 80: Left unciform of UF 256400.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASM3, third articular surface for the magnum; ASMC3, articular surface for metacarpal V; ASMC4, articular surface for metacarpal IV; ASMC5, articular surface for metacarpal V; ASC2, second articular surface for the cuneiform. Scale bar = 5 cm.

Magnum. The magnum (Figure 81) articulates proximally with the lunar, medially with the unciform, distally with the third metacarpal, and laterally with the trapezoid. Anteroposterior axis is the longest, followed by the dorsoventral, and the shortest axis is the mediolateral one. Greatest anteroposterior length is 160.0 mm, and greatest mediolateral width is 105.0 mm. Overall magnum shape is square and blocky. Magnum is complete but has a several chipped and weather articular surfaces.

In dorsal view, the entire surface is comprised of the articular surface for the lunar (ASL4). ASL4 mostly flat anteriorly but has a small posterior dome. Medial and lateral sides are concave whereas the anterior and posterior sides are convex. Some of the posterior surface is badly weathered but the ASL4 appears to be mostly smooth with no porousness. It also has several large osteolytic features in the center and one near the anterior side.

In medial view, the shape in this view is rectangular, like the medial side. Anterior outline is convex; posterior outline is distally convex and proximally concave; dorsal outline is anteriorly flat and posteriorly convex, and the ventral outline is concave. There are two articular surfaces on the medial side: the proximal articular surface (ASUN2) correlates with the proximal articular surface on the unciform's medial side and the distal articular surface that articulates with the distal articular surface on the unciform's medial side (ASUN3). The smooth ASUN2 stretches from the anterior edge to the posterior edge and has a rounded posterior end, a concave ventral border, and a relatively flat dorsal border before the posterior doming. ASUN2 has an anteroposterior length of 103.8 mm and a greatest mediolateral width of 54.0 mm. ASUN2 is smooth on the preserved surfaces but much of it is worn away, and there is a large osteolytic pathology along the dorsal edge in the center. ASUN3 is greatly chipped but it looks like it was small and slender. ASUN3 has an approximate anteroposterior length of 16.2 mm and

a mediolateral width of 10.0 mm. Beneath it, on the ventral side, is the articular surface for the third metacarpal's proximal articular surface (ASMC3(2)). ASUN3 and the ASUN2 are far apart with rugose, concave bone between them. Large foramina are along the center.

In ventral view, the main articular surface is the ASMC3(2). ASMC3(2) is long, concave, and triangular shaped. ASMC3(2) is 105.2 mm in anteroposterior length and has a greatest width of 55.6 mm. It is smooth, with a wrinkled anterior center, and shares a lateral border with the articular surface for the second metacarpal (ASMC2). ASMC2 is rectangular and curves proximally towards the lateral side. It is 107.7 mm in anteroposterior length and 44.0 mm in mediolateral width. It is concave and smooth, and the shared border between the two articular surfaces is smooth without any signs of wear.

In lateral view, the shape in this view is rectangular. Anterior and posterior sides are convex, more so distally, and the dorsal and ventral margins are concave. There are two articular surfaces on the medial side: the proximal articular surface (ASPTD) correlates with the proximal articular surface on the trapezoid's medial side and the distal articular surface that articulates with the distal articular surface on the trapezoid's medial side (ASDTD). The smooth ASPTD stretches from the anterior edge to the posterior edge and has a largely rounded anterior end with a concave ventral border and a relatively concave dorsal border. ASPTD has an anteroposterior length of 126.1 mm and a greatest mediolateral width of 50.0 mm. ASPTD is nearly separated into two different proximal articular surfaces due to the proximal extent of the ventral border's concavity. ASDTD is smooth, has elevated articular borders, and has wrinkles in its anterior surface. ASDTD is heavily chipped away but it looks like the facet was long and slender, stretching along the anteroposterior length. Beneath it, on the ventral side, is the articular surface for the third metacarpal's proximal articular surface ASMC2. ASDTD and the ASPTD

are close to touching anteriorly, with only a small concave rugose channel between them. The rest of the bone is also concave, rugose, and riddled with small foramina. Larger foramina are beneath the ASPTD's distal margin.

In anterior view, the magnum is square and is entirely rugose. There is a distal anteromedial knot with intercrossed soft tissue attachment fibers. This scarred knot extends to the distal anterolateral corner, narrowing. Above the distal anterolateral corner, there is a concave pocket of rugose bone with large foramina. Various sized foramina are all throughout the anterior surface.

In posterior view, the magnum's shape is triangular and it is almost entirely rugose. ASL4 makes the base and the posteroventral rugose apex becomes the point with the medial and lateral edges making slightly concave sides. The lateral outline does have a greatly extended distal portion that is visible, somewhat distorting the triangular shape. ASL4 also curves downwards into the posterior side. Posterior apex of the ASL4 rounds out just off center on the more lateral side of the posterior surface. Most of the surface is smoothly rugose with soft tissue attachment fibers webbing around the distal protrusion. Few foramina are visible.

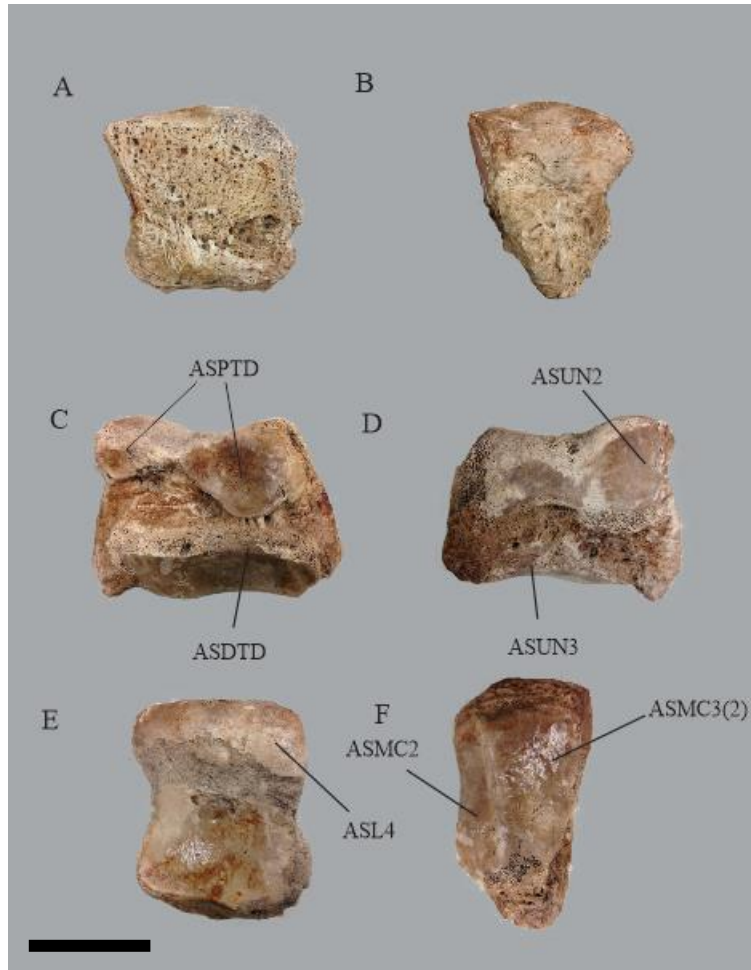


Figure 81: Left magnum of UF 256400.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASPTD, articular surface of the proximal trapezoid; ASATD, articular surface of the anterior trapezoid; ASDTD, articular surface of the distal trapezoid; ASL4, fourth articular surface of the lunar; ASMC2, articular surface for metacarpal II; ASMC3(2), second articular surface for metacarpal III; ASUN2, second articular surface for the unciform; ASUN3, third articular surface for the unciform. Scale bar = 5 cm.

Trapezoid. The trapezoid (Figure 82) articulates proximally with the scaphoid, medially with the magnum, distally with the second metacarpal, and laterally with the trapezium. It is anteroposteriorly elongate and both mediolaterally and dorsoventrally narrow. Greatest anteroposterior length is 136.5 mm and its greatest mediolateral width is 78.0 mm. Trapezoid is complete.

In dorsal view, the trapezoid shape is somewhat triangular. The medial outline is straight from the anterior edge to the center, where it then inwardly curves before straightening back out to the posterior edge. Lateral outline is less concave curved and more triangularly and inwardly pointed, with the inward apex in the center of the lateral edge. Anterior side is subtly convex with the medial corner more distally extended than the lateral corner. Posterior edge is convexly rounded. Most of the dorsal surface is comprised of the concave articular surface for the overlying scaphoid (ASS), except for some rugose anterior bone that extends beyond the articular border. Articular surface is smooth anteriorly and posteriorly but rough in the center. Proximal articulated surface for the magnum (ASPM) on the medial side is not visible in dorsal view.

In medial view, the shape is trapezoidal. Dorsal and lateral margins are moderately flat, whereas the anterior margin is convex, and the posterior margin is posteriorly convex and proximally flat. There are two proximal articular surfaces for the proximal articular surfaces on the magnum: the posterior (ASPM2) and the anterior (ASAM2). Each surface is oval shape but with a flat dorsal edge, and the anterior one is much larger. A concave channel separates the two articular surfaces and branches out to continue beneath them. ASPM2 is 41.4 mm in anteroposterior length and 24.0 mm in dorsoventral width. ASAM2 is 69.3 mm in anteroposterior length and 47.1 mm in dorsoventral width. ASAM2 is smooth anteriorly but

rough and porous everywhere else. Its articular surface appears flush with its borders. ASPM2 is smooth and has a raised distal and posterior articular border. The rest of the rugose bone is most smooth with very little foramina. Most of the foramina are located beneath the articular surfaces.

In ventral view, the trapezoid has the same shape as in dorsal view. Most of it is comprised of the articular surface for the second metacarpal (ASMC2(2)); however, the ASMC2(2) is thin and tear drop shaped, and much of the surrounding bone extends beyond it. Articular surface is smooth with no obvious porousness. The surface narrows posteriorly, where it also has a slight slant to the lateral side. Anteroposterior length is 112.7 mm and its anterior mediolateral width is 53.0 mm whereas the posterior mediolateral width tapers to 15.7 mm.

In lateral view, the trapezoid is triangular. Convex anterior margin is the base and the rounded posterior edge is the point. Dorsal outline is concave, and the ventral outline is convex. There is one articular surface (ASTM) for the articulation with the trapezium's medial side that looks like two fused surfaces. ASTM's anteroposterior length is 66.8 mm and its dorsoventral width is 33.7 mm anteriorly and 15.8 mm posteriorly. The surface is in the center of the medial side and the more proximal and posterior section is oval whereas the anterior section is more circular. Both sections are porous but the ASTM is smooth anteriorly. Surface is flush with the articular borders as well. The rest of the bone is rugose and concave with many foramina, especially beneath the articular surface. Anteriorly, the rugose bone becomes smoother and less concave.

In anterior view, the trapezoid is very round but with a nearly straight dorsal margin. The entire surface is rugose and smooth with several soft tissue attachment fibers webbing around the convex rugose surface. A pronounced and small nodule is on the medial side.

In posterior view, the rugose posterior tip forms a rounded protrusion. On either side of the knot, the medial and lateral sides are visible as they expand outwards. Above the center of the posterior nodule, there is the proximal triangular point where the ASS and ASPM connect. The protrusion is moderately smooth with soft tissue attachment fibers webbing around the protrusions tip.

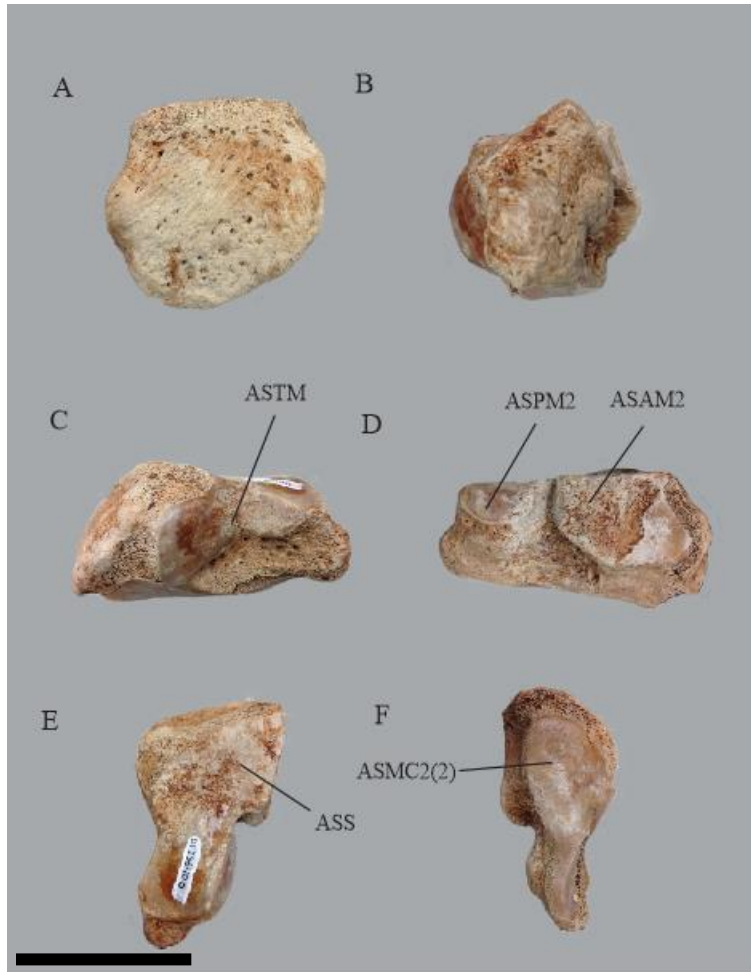


Figure 82: Left trapezoid of UF 256400.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASPM2, second articular surface of the posterior magnum; ASAM2, second articular surface of the anterior magnum; ASTM, articular surface for the trapezium; ASS, articular surface for the scaphoid; ASMC2(2), second articular surface for metacarpal II. Scale bar = 5 cm.

Trapezium. The trapezium (Figure 83) articulates proximally with the scaphoid, medially with the trapezoid, laterally with the first metacarpal, and distally with the MC2. Mediolateral and dorsoventral axis are nearly equal in length and larger than the anteroposterior axis. Trapezium's greatest dorsoventral length is 104.0 mm, and its greatest mediolateral width is 95.0 mm. General shape of the trapezium is a cylinder. Trapezium is complete.

In dorsal view, there is only one articular surface, which associates with the overlying scaphoid (ASS2). Articular surface is oval and deeply concave. Much of the surface is weathered but it appears to be smooth with no porousness. It is 60.2 mm in mediolateral length and has its greatest anteroposterior width is 34.1 mm. Remaining bone in the dorsal surface is rugose and depressed from the articular surface. A knot is anterolaterally oriented and has mediolateral soft tissue attachment fibers across its surface. Several large foramina are within the knot.

In medial view, there is only the articular surface for the lateral side of the trapezoid (ASTD). Most of the ASTD is an anterior large circular articular area, but it has a proximal oval extension that runs posteriorly. ASS2's proximal anteroposterior length is 70.3 mm and its greatest dorsoventral height is 37.8. The entire surface is smooth with a subtle ridge between the circular section and the proximal oval section.

In ventral view, the rugose bone has an anterior articular surface. There is a small circular articular surface in this view that shares a border with the ASTD. This surface (ASMC4(4)) articulates with the proximal articular surface on the lateral side of the fourth metacarpal. This concave articular surface is smooth, circular, and flush with its articular borders. It is 39.3 mm in mediolateral width and 14.6 mm in anteroposterior length. The rest of the bone is rugose and is concave beneath the articular surface. There are very few foramina.

In lateral view, there is only the oval articular surface for the first metacarpal (ASMC1). The dorsoventral length is 86.7 mm and its anteroposterior width is 55.6 mm. The raised surface has an dorsoventral length of 76.8 mm and a anteroposterior width of 33.3 mm. The raised articular surface is smooth, but porous centrally, and the rest is more porous and less smooth.

In anterior view, the bone is entirely rugose and flat, except for a central nodule. Foramina are scattered throughout the surface.

In posterior view, the rugose surface is slightly convex and has soft tissue attachment fibers running dorsoventrally.

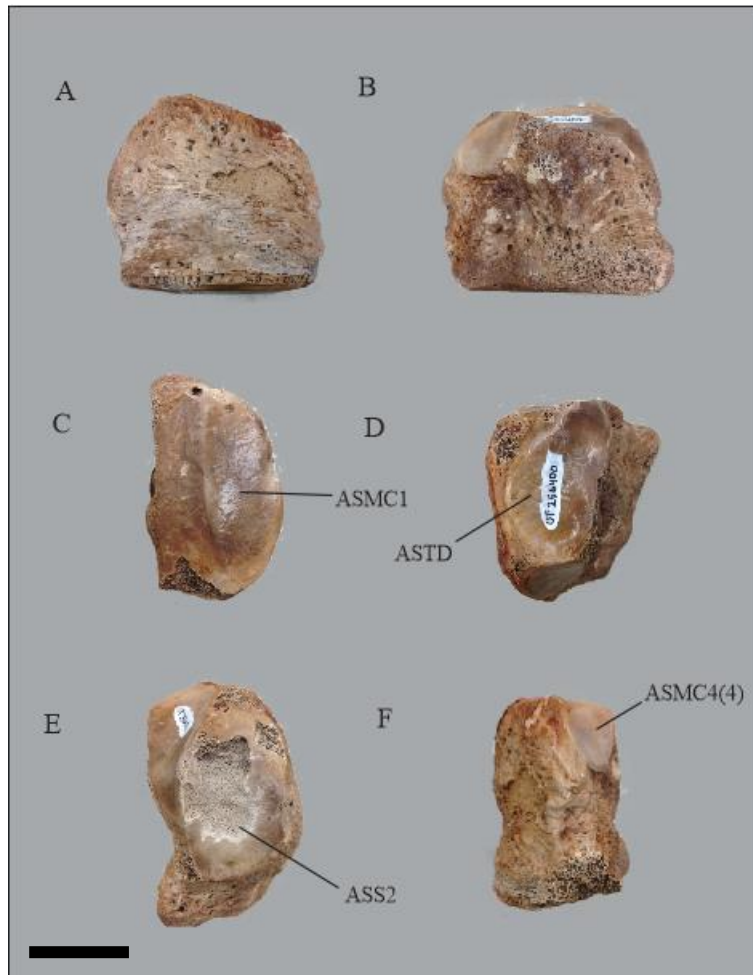


Figure 83: Left trapezium of UF 256400.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASMC1, articular surface for metacarpal I; ASTD, articular surface for the trapezoid; ASS2, second articular surface for the scaphoid; ASMC4(4), fourth articular surface for metacarpal IV. Scale bar = 5 cm.

Metacarpals

Metacarpal I. The first metacarpal (MC1) articulates proximally with the trapezium, and distally with the proximal phalanx for the first digit and two sesamoids. MC1 is dorsoventrally elongate, with narrow mediolateral and anteroposterior axes. Dorsoventral length is 134.0 mm; its greatest anteroposterior width is 75.0 mm; and its greatest mediolateral width is 118.0 mm. MC1 is broken, missing its distal end, and has a few chipped surfaces.

In dorsal view, the articular surface for the trapezium (ASTM2) is the prominent feature. ASTM2 is oval shaped, mostly flat but with a slight raised center, and is porous in the center. ASTM2's anteroposterior length is 45.4 mm and the mediolateral width is 88.1 mm. The raised center has an anteroposterior length of 32.9 mm and a mediolateral width of 75.8 mm. No rugose bone is seen extending beyond the articular surface.

In medial view, the anterior and posterior curvatures are concavely inward into the MC1 shaft. Dorsal edge is flat. Anterior distal end is broken off and missing. There is no proximal articular surface and the entire surface is rugose with foramina.

In ventral view, the bone is broken, revealing interior cancellous bone. Some of the sesamoid surfaces are preserved and smooth.

In lateral view, the overall shape reflects that described for the medial side and the bone is rugose with no articular surfaces.

In anterior view, the medial and lateral sides are concave and the dorsal margin is flat. Proximal anterior corner has a rugose ridge outlined by foramina and the MC1 shaft is smooth without the wrinkled rugose texture. Foramina are scarce until the proximal and anterior distal ends.

In posterior view, the bone is concave and has the same general shape as the anterior side. Sesamoid surfaces are convex but are too broken for measurements. The surfaces are smooth. Large foramina are above the sesamoid margins. There is no proximal posterior protrusion.

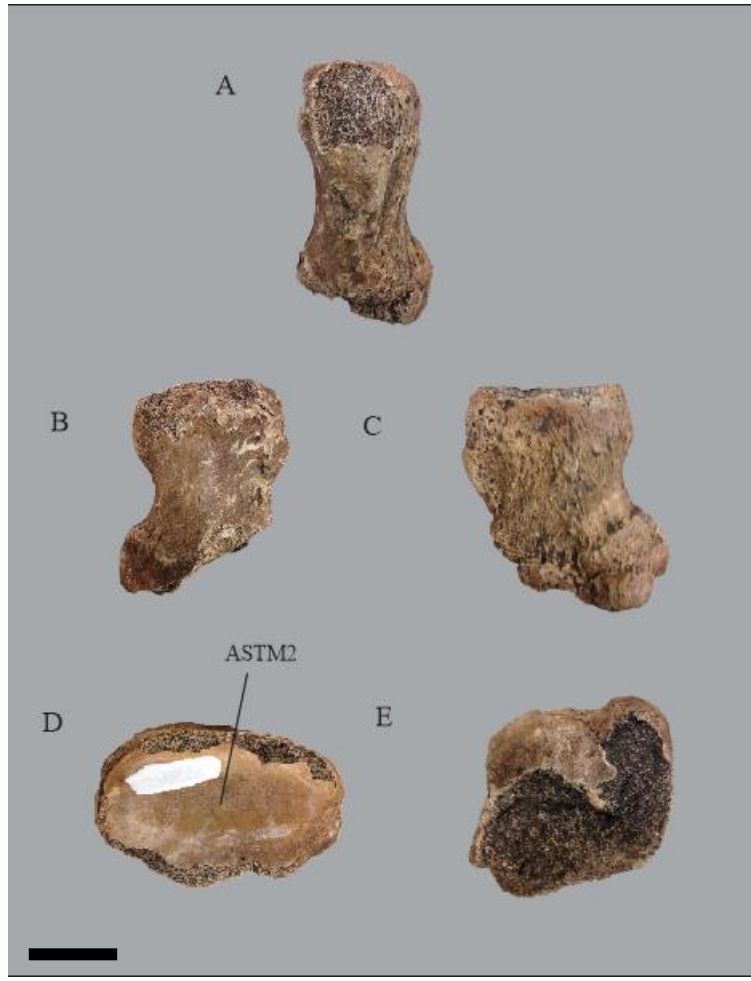


Figure 84: Left Metacarpal I of UF 256400. A, posterior; B, lateral; C, medial; D, dorsal; E, ventral. ASTM2, second articular surface for the trapezium. Scale bar = 5 cm.

Metacarpal II. The second metacarpal (MC2) (Figure 85) articulates proximally with the trapezoid, dorsomedially with the magnum, medially with the third metacarpal (MC3), laterally with the MC1, and distally with the proximal phalanx for the second digit (AS2PP) and two sesamoids. As a typical metacarpal, the MC2 is dorsoventrally elongate and mediolaterally and anteroposteriorly narrow. Greatest dorsoventral length is 225.0 mm; greatest mediolaterally width is 106.0 mm; and greatest anteroposterior width is 128.0 mm. MC2 is complete.

In dorsal view, the MC2 is somewhat rectangular, but the lateral outline is greatly concave. Anterior edge is flat except for a proximal medial rugose knot. Posterior outline is convex and the medial outline is flat. There are two articular surfaces that have a connective border. Main medial articular surface (ASLM) articulates with the distal articular surface on the lateral side of the magnum (ASMC2). The smaller dorsal articular surface (ASTD2) articulates with the trapezoid's ventral surface (ASMC2(2)). Connective articular margin between the two surfaces is straight, starting at the anterior rugose knot and cutting to the posterior extension. Anteroposterior length of ASTD2 is 108.8 mm and its greatest mediolateral width, which is anteriorly located, is 54.5 mm and tapers to 24.2 mm. Anteroposterior length of the ASLM is 90.5 mm and the greatest width is 32.7 mm. It has a raised surface that is 69.2 mm in anteroposterior length and 26.7 mm in mediolateral width. Both surfaces are smooth, even along their conjoined margin, which is the most elevated proximal point.

In medial view, the MC2 is moderately straight with almost no concave curve. Greatest concavity is seen just below the proximal articular surface (ASMC3(3)), which articulates with the proximal articular surface on the lateral side of the third metacarpal (ASMMC2). MC2's medial side is composed of rugose bone with very few foramina. This articular surface is a long slender rectangle that is smooth. Anteroposterior length of the ASMC3(3) is 93.7 mm and its

dorsoventral height is 30.9 mm. Articular rims are flush with the articular surface, except anteriorly. There is a rugose ridge that runs anteroposteriorly at the distal end. MC2 shaft is very smooth without the wrinkled rugose texture.

In ventral view, the articular surface for the proximal phalanx of the second digit is the most prominent (AS2PP) feature. Anteroposterior length of the AS2PP is about 85.4 mm and the mediolateral width is greatest at 86.2 mm. It has a raised center that is 66.5 mm in length and 66.9 mm in width. Articular surface is very circular and light in color. A darker section of smooth surface cuts mediolaterally across and separates the AS2PP from the articular surfaces of the medial and lateral sesamoids that are posteriorly located from the AS2PP. The dark section is 21.8 mm in anteroposterior length between the AS2PP and sesamoid surfaces. AS2PP has a large osteolytic pathology located near the center. Anterior articular borders for the AS2PP are flush with the surface, even the anterior rim.

In lateral view, the anterior and posterior curvatures are concave and the ventral curvature is convexly U-shaped. Dorsal outline is concave. There is a small proximal anterior articular surface (ASTM3) that articulates with the trapezium's articular surface on the ventral side. It has a 29.1 mm anteroposterior length and a 36.8 mm dorsoventral height. The rest of the surface is rugose although the main MC2 shaft is smooth without the wrinkled rugose texture. Little foramina are visible except along the distal and proximal rims. There is also a mediolateral rugose ridge on the distal section.

In anterior view, the bone is entirely rugose. Medial outline is mostly flat, and the lateral side is slightly concave. Ventral surface is moderately flat. Dorsal margin is mostly concave. AS2PP extends into the anterior side and is smooth, with large foramina border the rim. Its apex

is more medially oriented. Proximally, the bone is anteriorly extended and smooth with soft tissue attachment fibers running from the lateral corner to the center.

In posterior view, there is a large rugose protrusion extending from the center and curves laterally. Few foramina are visible in the rest of the concave rugose body. Distal medial and lateral sesamoid surfaces are the most prominent features. Medial sesamoid surface is 59.8 mm in dorsoventral height and its mediolateral width is 28.5 mm. Lateral sesamoid surface is greatly chipped but it is 50.3 mm in dorsoventral height, and its mediolateral width is 52.7 mm. A ridge separates the surfaces, which are very smooth and flush with their articular borders.

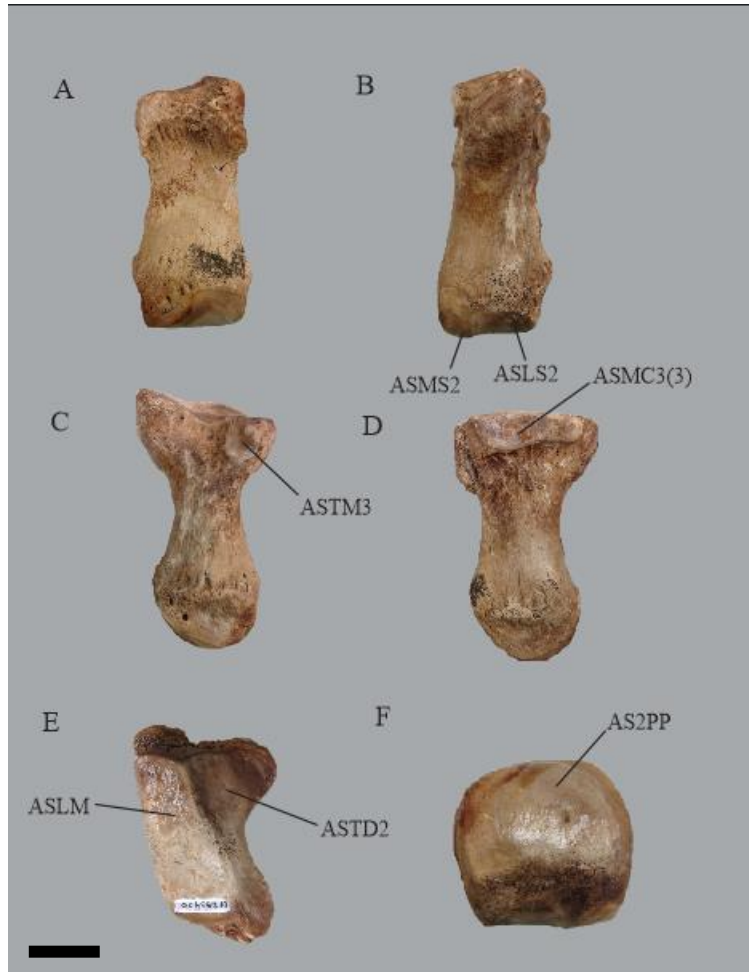


Figure 85: Left Metacarpal II of UF 256400.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASMS2, articular surface for the medial sesamoid of digit II; ASLS2, articular surface for the lateral sesamoid of digit II; ASTM3, third articular surface of the trapezium; ASMC(3), third articular surface for metacarpal III; ASLM, articular surface for the lateral side of the magnum; ASTD2, second articular surface for the trapezoid; AS2PP, articular surface for the proximal phalanx of digit II. Scale bar = 5 cm.

Metacarpal III. The third metacarpal (MC3) (Figure 86) is the largest metacarpal and it articulates proximally with the magnum, dorsolaterally with the unciform, medially with the second metacarpal, laterally with the fourth metacarpal, and distally with the proximal phalanx for the third digit and two sesamoids. It's dorsoventrally elongate and anteroposteriorly and mediolaterally narrow. Its greatest dorsoventral length is 242.0 m; its greatest mediolateral width is 102.0 mm; and its greatest anteroposterior width is 137.0 mm. MC3 is complete.

In dorsal view, the shape is very triangular with the anterior edge making the base and the rounded posterior making the point. Two articular surfaces encompass the dorsal surface. The first, and more central, is the articular surface for the magnum (ASM4), which articulates with the magnum's distal surface (ASMC3(2)). Its anteroposteriorly 107.5 mm long, and has a central mediolateral width of 52.0 mm. The other dorsal articular surface connects dorsolaterally with the unciform (ASUN3), articulating with the distal articular surface on the unciform's medial side (ASMC3). Its anteroposterior length is 90.7 mm and it is mediolaterally 34.2 mm wide. Its raised center is 69.0 mm in length and 27.8 mm wide. Both articular surfaces share a conjoined border, which forms a medially concave line from the anterior side to the posterior. The connective margin is the highest point of the MC3 and is smooth. ASUN3 is lighter colored and smoother than the ASMC4's articular surface, which is dark and porous. Both surfaces are smooth and there is a small osteolytic pathology along the medial margin of the ASM4.

In medial view, the anterior and posterior sides are concave, with the posterior outline more so. Both the dorsal and ventral curvatures are convex, with the ventral U-shaped. Most of the bone is rugose, but there is a proximal articular surface (ASMC2(3)), which articulates with the MC2. ASMC2(3) is long, slender, rectangular, and has a anteroposterior length of 95.7 mm and a dorsoventral height of 31.7 mm. The surface is smooth anteriorly with some posterior porous in

its center. The articular borders are slightly raised above the articular surface. The rest of the bone is rugose, though more so proximally and distally with a smooth center. Bone is concave beneath the ASMC2(3) with several foramina outlining the margin. Rugose bone beneath the ASMC2(3) is also very wrinkled in appearance. Distally, there is a slight ridge of bone extending from the anterior margin and to the center of the U-shape, framed by many large foramina.

In ventral view, there is a large dark, smooth circle articular surface for digit III's proximal phalanx and the posteriorly oriented sesamoid surfaces. Greatest anteroposterior length of the AS3PP 83.0 mm, and the greatest width is about 86.6 mm. Its raised center has an anteroposterior length of 55.7 mm and a mediolateral width of 65.4 mm. The raised center is light colored and more medially oriented. Much of the AS3PP is smooth, especially its raised surface, but there is porousness anterolaterally located and several small osteolytic features are within the surface. Some are near the center, one is along the lateral margin, and others are bordering the sesamoid surfaces. All the holes are small and barely noticeable. There is not a non-articular separation between the AS3PP and the sesamoid surfaces. Overall, the ventral surface looks very square.

In lateral view, the anterior and posterior curvatures are concave whereas the dorsal and ventral outlines are convex. Most of the lateral bone is rugose but there is a proximal articular surface, which articulates with the fourth metacarpal (ASMC4(2)). This articular surface is a large oval. It is at least 36.8 mm in anteroposterior length and has a greatest dorsoventral height of 29.1mm. This surface is smooth anteriorly with some dimpling of the bone, and it is more porous posteriorly. Articular borders are flush with the articular surface, except anteriorly. Rugose bone is concave beneath the articular surface with large foramina, along with soft tissue attachment fibers that run dorsoventrally. Distally, there is a rugose ridge running along the

mediolateral width, and this ridge is smooth, as is the rugose bone beneath it, which has only two posterior foramina. MC3 shaft is very smooth without the wrinkled rugose texture and the distal MC3 is narrow compared to the proximal head.

In anterior view, the MC3 is very symmetrical. Medial and lateral sides are slightly concave, extending distally. Dorsal margin comes to a triangular point laterally where the ASM4 and the ASUN3 connect. Ventral outline is almost flat. Many foramina are located along the ventral margin and the proximal section has a medial rugose nodule and a lateral rugose ridge. The medial nodule is smooth and almost connects with the lateral ridge in the center. Both features have soft tissue attachment fibers oriented from the dorsomedial corner towards the ventrolateral corner. AS3PP curves up into the anterior plane with its convex apex centrally located.

In posterior view, the MC3 is less symmetrical and it gradually narrows proximally. Medial and lateral sides are still concave, as is the ventral outline, and the dorsal outline is more convex than triangularly pointed. There is a large rugose proximal protrusion, and the MC3 body becomes concave beneath it before extending back out to the sesamoid surfaces. The rugose bone does not have many foramina or soft tissue attachment fibers and is moderately smooth. Distally, the two sesamoids surfaces have a ridge almost symmetrically between them. Both the medial and lateral sesamoid surfaces are badly chipped, but with what is present, the ASMS3 is 61.0 mm dorsoventrally long and 41.7 mm mediolaterally wide. ASLS3 is at least 51.0 mm in dorsoventral length and is 34.3 mm mediolaterally wide. Both surfaces are smooth and look as if they had raised centers. ASMS3 is darker than the ASLS3. Some foramina are visible above the sesamoid surfaces.

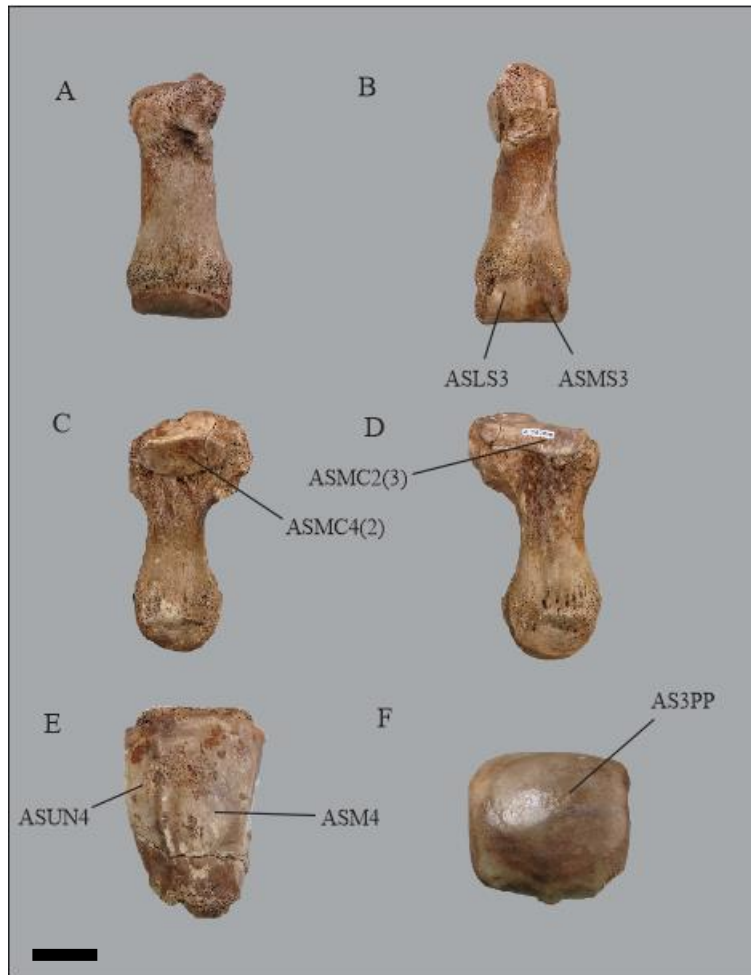


Figure 86: Left Metacarpal III of UF 256400.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASLS3, articular surface of the lateral sesamoid of digit III; ASMS3, articular surface of the medial sesamoid of digit III; ASMC2(3), third articular surface for metacarpal II; ASMC4(2), second articular surface for metacarpal IV; ASUN4, fourth articular surface for the unciform; ASM4, fourth articular surface for the magnum; AS3PP, articular surface for the proximal phalanx of digit III. Scale bar = 5 cm.

Metacarpal IV. The fourth metacarpal (MC4) (Figure 87) articulates proximally with the unciform, dorsomedially with the third metacarpal, laterally with the fifth metacarpal, and distally with the proximal phalanx associated with the fourth digit and two sesamoids. MC4 is dorsoventrally elongate and mediolaterally and anteroposteriorly narrow. Greatest dorsoventral height is 217.0 mm; greatest mediolateral width is 104.0 mm; and its greatest anteroposterior width is 122.0 mm. MC4 is complete but has several chipped surfaces.

In dorsal view, the shape of MC4 is triangular, with the anterior margin forming the base and the posterior end forming the rounded point. Anterior, lateral, and posterior margins are convex. The medial outline is slightly concave. The entire dorsal surface is the articular surface that articulates with the distal articular surface of the unciform, or the ASMC4. This surface, ASUN5, is slightly porous. Its central mediolateral width is 56.11 mm and its greatest anteroposterior length is 92.9 mm. Articular outlines for the ASUN5 match the MC4's overall outline, except that the ASUN5's medial outline is concave, not convex. Rugose bone is visible beyond the anteromedial margin of the ASUN5. In dorsal view, the proximal articular surface on the medial side is also visible as it extends outwards medially. This articular surface articulates with the third metacarpal's proximal articular surface on its lateral side (ASMC4(2)). Articular surface (ASMC3(4)) shares an articular border with ASUN5. ASMC3(4)'s proximal articular border is the ASUN5's medial articular border. In dorsal view, the ASMC3(4) gives the MC4 a convex medial outline.

In medial view, the main feature is the proximal articular surface, ASMC3(4). This articular surface is very oval shaped, long and slender. Proximal articular surface is smooth with no porousness and the articular border is raised above the articular surface. ASMC3(4) is 95.7 mm in anteroposterior length and 31.7 mm in dorsoventral width. Articular surface is smooth

with a dark center, and its distal articular border is raised above the surface whereas the rest of the border is flush with it. Rest of the MC4 in medial view is rugose, and the rugose bone is concave beneath the proximal articular surface. Overall, the posterior outline is concave beneath its proximal extension before broadening back out to the posterior distal curvature for the sesamoids. Anterior margin is also concave, though not as deeply as the posterior outline. Like the posterior outline, the anterior outline widens back out for the ventral curvature, which is very convex and U-shaped. The distal end is not as broad as the proximal head. Foramina are located in the proximal concavity and distally. Most of the MC4 shaft is smooth without the wrinkled rugose texture and soft tissue attachment fibers run dorsoventrally.

In ventral view, the articular surface for the proximal phalanx for the fourth digit (AS4PP) is most prominent, and the two articular surfaces for the sesamoids are visible posterior to it. Sesamoid surfaces extend into the posterior view whereas the phalanx curve extends into the anterior view. AS4PP has a greatest anteroposterior length of about 73.3 mm and a greatest mediolateral width of about 83.8 mm. Bone is thicker on the medial side and narrows laterally, where the articular surface is more porous. Medial section of the AS4PP is lighter colored and smooth. Although this surface is badly chipped, there appears to have been several osteolytic features, mostly centrally clustered but a few are along the medial and lateral margin. Anterior articular border is raised above the AS4PP. Furthermore, there is a dark space of bone between the AS4PP and the sesamoid surfaces that is about 33.5 mm in anteroposterior width.

In lateral view, there is one articular surface. Proximal articular surface articulates with the proximal articular surface on the medial side of the fifth metacarpal, ASMC4(3). MC4's proximal articular surface (ASMC5(2)) is oval but with a straight dorsal edge. It is centrally smooth with porous edging and its articular borders are not flush with the surface. It has an

anteroposterior width of 73.0 mm and a dorsoventral length of 25.7 mm. The center of the surface is elevated uniformly about 5.0 mm from the borders. Rugose bone is deeply concave beneath the articular surface with several foramina. Very few foramina are visible throughout the rest of the rugose bone, but there are some in the center, distally. Most of the surface is smooth except for a rougher rugose texture distally within the U-shape curvature.

General shape of the MC4 is also similar to the medial side. Dorsal outline is flat and more proximally extended at the posterior edge. Whereas the ventral outline is greatly convex, with a anteroposteriorly wide U-shape. Posterior outline is greatly concave beneath is proximal posterior extension and it expands outwards again with the start of the U-shape distal end. Anterior outline is also concave but to a lesser extent.

In anterior view, the dorsal outline is convex with the apex medially oriented. Medial and lateral outlines are slightly concave with the lateral side being more straight. Ventral outline is subtly concave. Distal and proximal ends are very rugose with scattered foramina and the MC4 shaft is smooth without the wrinkled rugose texture but with a lateral, circular groove below the center. The rugose proximal end is more anteriorly extended.

In posterior view, the medial and lateral sides are slightly concave proximally before flaring back out distally. Ventral outline is concave, and the medial corner extends more distally than the lateral. Most of the posterior bone is rugose and concave beneath the proximal posterior protrusion and above that sesamoid articular surfaces. The sesamoid facets curve into the posterior side from the ventral edge. Above them, there are a few foramina. The rest of the bone is smooth, including the rugose posterior protrusion which has mediolaterally oriented attachment fibers. There is a raised ridge on the articular surface between the lateral and medial articular sesamoid surfaces (ASMS4 and ASLS4). Dorsoventral length of the ASMS4 is about

47.1 mm and its mediolateral width is about 30.9 mm. Greatest dorsoventral length of the ASLS5 is 44.0 mm, and its greatest mediolateral width is about 37.0 mm. Both surfaces are rough, with the medial sesamoid more porous, especially towards its medial margin.

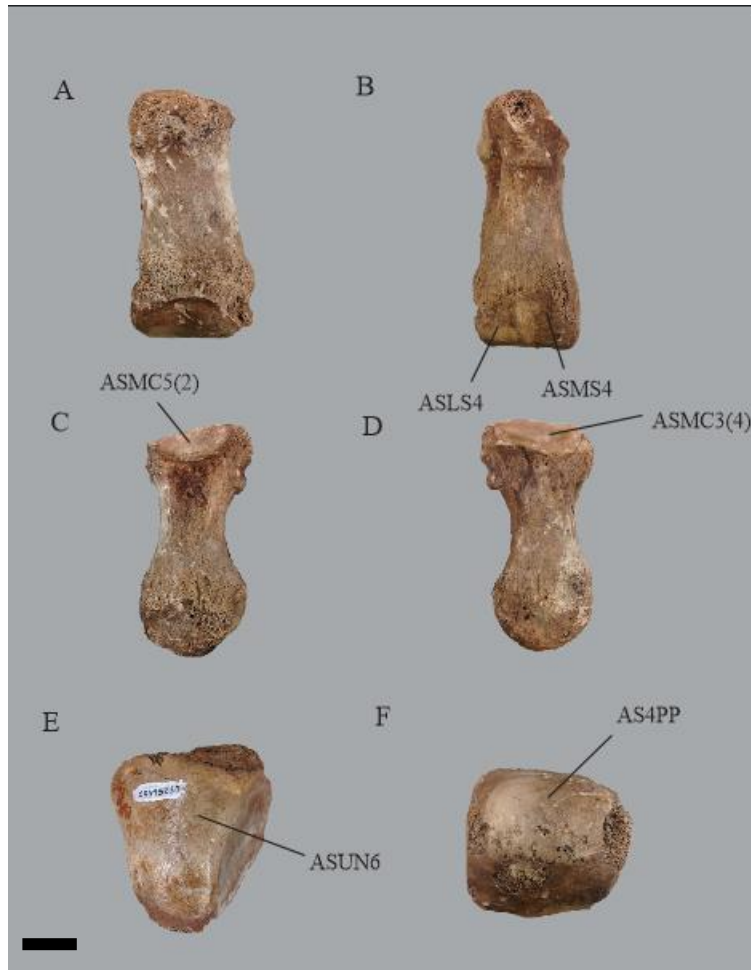


Figure 87: Left Metacarpal IV of UF 256400.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASMS4, articular surface for the medial sesamoid to metacarpal IV; ASLS4, articular surface for the lateral sesamoid to metacarpal IV; ASMC3(4), fourth articular surface to metacarpal III; ASMC5(2), second articular surface to metacarpal V; ASUN6, sixth articular surface for the unciform; AS4PP, articular surface for the proximal phalanx of digit IV. Scale bar = 5 cm.

Metacarpal V. The fifth metacarpal (MC5) (Figure 88) articulates proximally with the unciform, medially with the fourth metacarpal, laterally with the cuneiform, and distally with the proximal phalanx for the fifth digit and two sesamoids. MC5 is dorsoventrally elongate and mediolaterally and anteroposteriorly broad. Its greatest dorsoventral length is 183.0 mm; its greatest anteroposterior width is 111.5 mm; and its greatest mediolateral width is 125.0 mm. MC5 is complete.

In dorsal view, the shape of MC5 is oval with anterior and posterior rugose protrusions extending beyond the articular surfaces. Dorsal surface is comprised of the articular surface for the unciform (ASUN4), which articulates with the unciform's articular surface on its lateral side (ASMC5). ASUN4 is mostly oval but has a flat medial edge. ASUN4's greatest anteroposterior length is about 82.4 mm, and its greatest mediolateral width, located centrally, is about 68.3 mm. ASUN4 is very porous in its center and darkly colored, but smooth at its posteromedial corner, which is light colored and elevated above the rest of the articular surface. ASUN4 also has an elevated center with an anteroposterior length of about 68.1 mm, and its greatest mediolateral width is about 33.7 mm. ASUN4's is flush with its articular borders, except posteriorly. Proximal articular surfaces on the medial and lateral side are also in view flanking the ASUN4 has the extend outwards.

In medial view, the ASMC4(3) is the most notable feature whereas the rest of the bone is rugose with various foramina. ASMC4(3) is small and oval shaped but with a straighter dorsal edge. Articular surface is smooth anteriorly and porous posteriorly. The smooth surface is lighter in color than the porous surface. Greatest anteroposterior length is about 64.2 mm and its greatest dorsoventral height is about 29.2 mm. ASMC4(3) also has a raised center with an anteroposterior length of 50.5 mm and a dorsoventral height of 20.7 mm. Both the posterior and anterior outlines

are barely concave. There is a proximal anterior rugose nodule with many foramina and the distal surface is rugosely smooth with a few foramina within. A single large foramen is situated in the center above the distal rugose surface. Rest of the MC5 shaft is very smooth without the wrinkled rugose texture.

In ventral view, the articular surface for the proximal phalanx for the fifth digit (AS5PP) is most prominent, and the two articular surfaces for the sesamoids are visible posterior to it. The sesamoid surfaces extend into the posterior view whereas the phalange curve extends into the anterior view. AS5PP has a greatest anteroposterior length of about 80.7 mm and a greatest mediolateral width of about 87.4 mm. This circular surface is very smooth but with a darker porous center, and dark porous edges. Besides the anterior rim, the articular borders are flush with the surface and little porousness was observed. Between the AS5PP and the sesamoid surfaces, there is a dark band of smooth bone, about 9.3 mm wide, that is very porous.

In lateral view, there is a small articular surface for the cuneiform, or ASC3. This articulates particularly with the cuneiform's ventral section of its lateral projection. The concave ASC3 is about 60.0 mm anteroposteriorly long and has a greatest dorsoventral height of 29.3 mm. The surface is very porous and flush with its articular borders. MC5 has slightly concave anterior and posterior sides, the ventral contour is convex, and the dorsal outline is triangular pointed in the center. Beneath the proximal articular surface is a large rugose ridge that extends across the whole mediolateral width with attachments fibers similar oriented. Foramina are between the ridge and the ASC3. Rest of the surface is rugose, partially, chipped, and has several scattered foramina.

In anterior view, the medial and lateral sides are slightly concave, with the lateral side being almost straight, whereas the ventral contour is convex, and the dorsal contour is mostly

concave but with a proximal lateral extension. AS5PP curves up slightly into the anterior plane with its apex medially oriented. The distal end is rugose with various foramina and the proximal end is also very rugose with a lateral protrusion. The protrusion has attachment fibers oriented dorsomedially to ventrolaterally. Proximal rugose surface is anteriorly extended with some foramina. MC5 shaft is smooth without the wrinkled rugose texture and has no foramina.

In posterior view, the medial, lateral, and ventral sides are slightly concave and the dorsal outline is triangularly convex. Most of the posterior bone is rugose and there is a central concavity with a lateral nodule above it. Proximally, the rugose bone is posteriorly extended and has mediolaterally oriented attachment fibers with several foramina throughout. Distally, there is a raised ridge between the lateral and medial articular sesamoid surfaces (ASMS5 and ASLS5). Greatest dorsoventral length of the ASMS5 is about 63.2 mm and its mediolateral width is about 38.4 mm. Greatest dorsoventral length of the ASLS5 is 67.5 mm, and its greatest mediolateral width is about 51.6 mm. Both surfaces have circular raised centers that are entirely smooth and lighter in color than the depressed porous surfaces that outline them. ASMS5's raised central surface is 51.3 mm in length and it is 33.5 mm wide. ASLS5's raised central surface is 44.5 mm in length and is 42.0 mm wide.

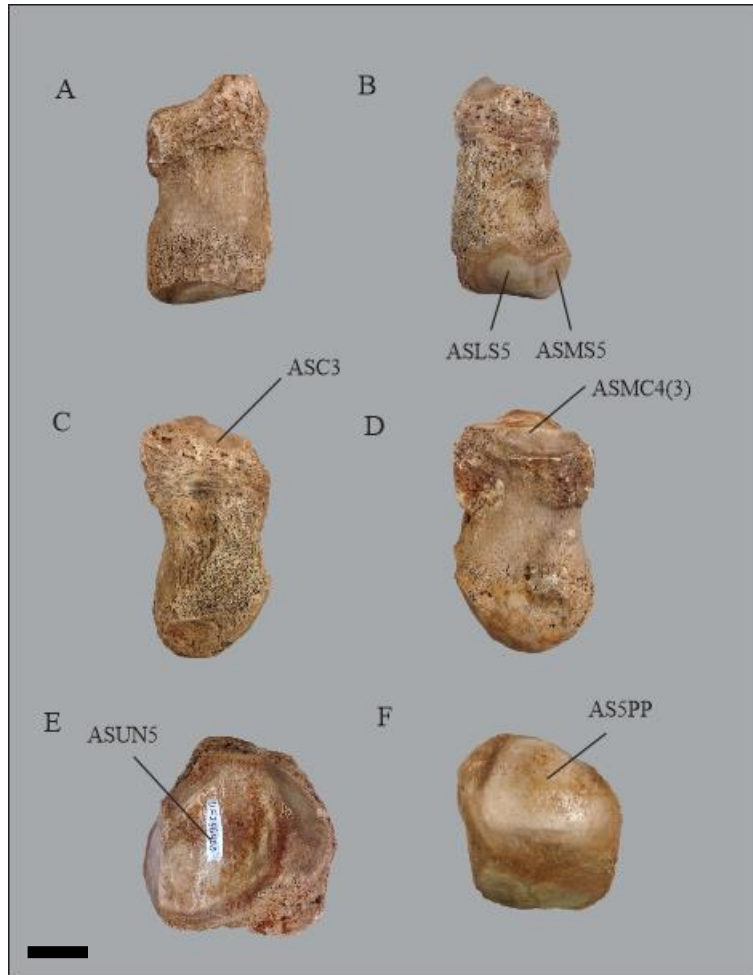


Figure 88: Left Metacarpal V of UF 256400.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASLS5, articular surface for the lateral sesamoid of digit V; ASMS5, articular surface for the medial sesamoid of digit V; ASC3, third articular surface for the cuneiform; ASMC4(3), third articular surface for metacarpal IV; ASUN5, fifth articular surface for the unciform; AS5PP, articular surface for the proximal phalanx of digit V. Scale bar = 5 cm.

Phalanges

Proximal Phalanges

Proximal Phalanx Digit II. The proximal phalanx for digit II (PP2) (Figure 89) articulates proximally with the distal surface of Metacarpal II and distally with the proximal surface of the medial phalanx for digit II. It is dorsoventrally elongate and mediolaterally and anteroposteriorly narrow. Its greatest dorsoventral length is 121.0 mm; its greatest mediolateral width is 88.0 mm; and its greatest anteroposterior width is 77.0 mm. PP2 is very complete.

In dorsal view, the circular articular facet that articulates with the distal articular surface of the second metacarpal is the prominent feature (ASDMC2). ASDMC2 is about 79.4 mm in greatest mediolateral width and 71.0 mm in greatest anteroposterior length. Shape of the facet is more tear dropped, with the lateral side comprising the point, with rugose bone extending beyond the articular surface. The articulation itself is concave with the posterior side extending more proximally than the anterior section. Articular surface is mostly smooth, especially medially, and is porous laterally. The smooth center has three large hole pathologies, a pair side by side mediolaterally and a more anterior one. Most of the articular border is raised above the articular surface except for a small anterolateral section. Posterolaterally, there is a small, thin area of rugose bone that extends beyond the articular border.

In medial view, the posterior, anterior, and dorsal outlines of the bone are all inwardly concave whereas the ventral outline is convexly U-shaped. Anterior curvature is also more pronounced than the posterior's. Medial side itself is concave with a distal rugose extension of bone within the U-shape contour. Foramina are above the mediolateral width of the extension and are proximally located as well. There is a small proximal posterior nodule of rugose bone too.

Proximal and distal rugose surfaces have attachment fibers running in various directions but mostly mediolaterally proximally and dorsoventrally distally.

In ventral view, the oval articular surface that articulates with the proximal articular surface for the medial phalanx of digit II (ASPMP2) is the prominent feature and has a raised circular center within the center of the ventral surface, not extending anteriorly or posteriorly. Ventral facet is about 70.8 mm in greatest mediolateral width and has an anteroposterior length of about 43.1 mm. The raised center is 33.4 mm in width and has a 52.8 mm length. The raised surface is very roughly textured posteriorly and medially but smoother anteriorly and laterally. There is a large osteolytic pathology near the medial side of the raised surface. The hole is jaggedly shaped instead of perfectly round, but the edges are smooth and part of the surface depresses and recedes anteriorly from the hole.

In lateral view, the anterior outline is subtly concave whereas the posterior outline is convex. Dorsal outline is flat but more proximally extended posteriorly, and the ventral outline is convexly U-shaped. Lateral side is very rugose with several attachment fibers variously oriented and riddled with foramina, mostly on the proximal end. There is an extend posterior knot proximally and an extended distal section within the confines of the U-shape curvature.

In anterior view, the rugose bone is mostly is curved towards the medial side. Lateral side is convex whereas the medial side is concave, and both the dorsal and ventral outlines have convex centers. The bone is rugose, with very little of the ASPMP2 curving into the anterior side. Most of the distal rugose bone is anteriorly extended with mediolaterally oriented attachment fibers. Much of the bone is riddled with large foramina.

In posterior view, the bone is very rugose with large, light colored, attachment scarring in its proximal center. Much of the distal surface is chipped away, but some of the smooth cartilage surface is present laterally. Some of the bone beneath the large central scar is concave near the medial margin but does not appear so near the lateral margin. There is also a concave depression within the scar, just below the dorsal margin. The scar is smooth with dorsoventral attachment fibers in the center and mediolateral attachment fibers proximally. Some foramina are visible in the center of the PP2. Medial outline is concave whereas the dorsal and ventral outlines are convex, especially distally, and the lateral outline appears almost straight.

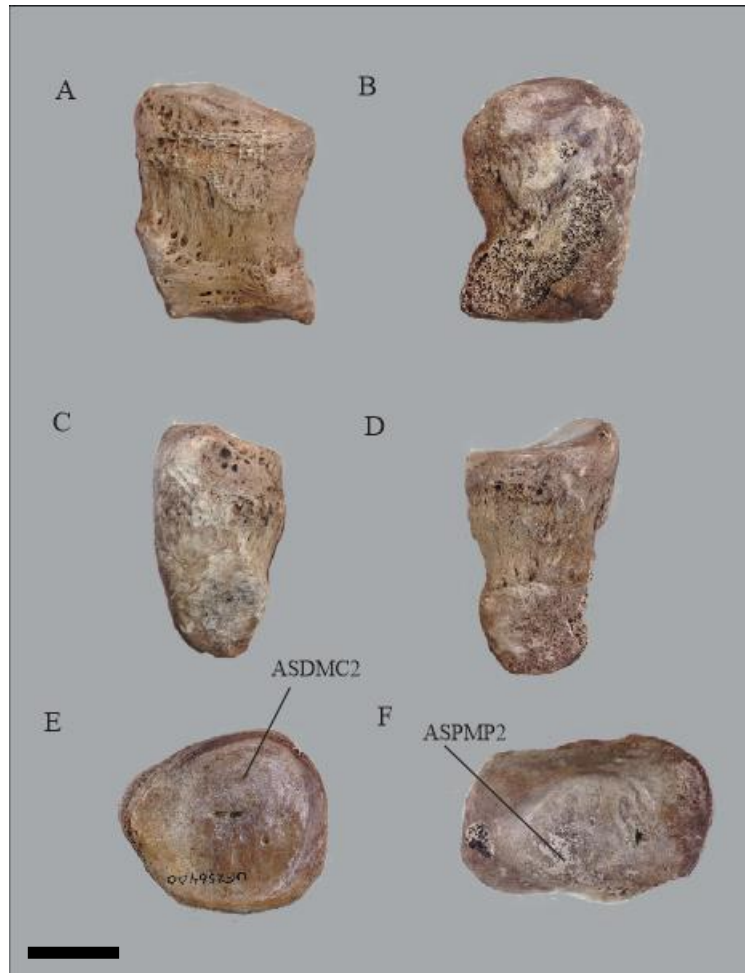


Figure 89: Left proximal phalanx of digit II of UF 256400. A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASPMP2, articular surface to the proximal surface of the medial phalanx of digit II; ASDMC2, articular surface to the distal surface of metacarpal II. Scale bar = 5 cm.

Proximal Phalanx Digit III. The proximal phalanx for digit III (PP3) (Figure 90) articulates proximally with the distal surface of Metacarpal III and distally with the proximal surface of the medial phalanx for digit III. It is dorsoventrally elongate and mediolaterally and anteroposteriorly narrow. Its greatest dorsoventral length is 114.0 mm; its mediolateral width is 89.0 mm; and its greatest anteroposterior width is 74.0 mm. PP3 is very complete but with some chipping.

In dorsal view, the entire surface is comprised of the articular surface that articulates with the distal articular surface of the third metacarpal (ASDMC3). This slightly concave articular surface is about 79.8 mm in mediolateral width and 61.7 mm in greatest anteroposterior length. Overall shape is symmetrically circular and mostly smooth, with very little porousness noted. It also has two central depressions where osteolytic features were beginning to form.

In medial view, the rugose bone and has two large foramina, one proximally centered and one posteriorly centered, and smaller foramina are along the dorsal margin. There are no obvious foramina in the distal area. Posterior and anterior curvatures are concave, the posterior side more so. The dorsal ridge is flat and more proximally extended posteriorly. Ventral margin is convexly U-shaped. The distal rugose bone is expanded medially and is smooth with some anteroposteriorly oriented attachment fibers.

In ventral view, the articular surface that articulates with the proximal articular surface on the medial phalanx for the digit III is the prominent feature (ASPMP3). Much of the anterior surface of the ASPMP3 is chipped away. This surface is an oblong, symmetrical oval and has a raised center. It is about 23.1 mm in mediolateral width and is 38.6 mm in anteroposterior length, and its raised surface is 56.4 mm in width and 36.8 mm in length. Most of the surface is smooth with very little porousness, and the raised surface is lighter in color.

In lateral view, the rugose bone symmetrically mirrors shape described on the medial side; however, the flat dorsal edge is less proximally extended posteriorly. The center is concave with both an extended mediolateral proximal ridge and an extended distal section with the confines of the U-shape curvature. Most of the foramina are below the proximal ridge and above the distal extension.

In anterior view, the PP3 is very rugose and symmetrical. Both the medial and lateral outlines are concave, and the dorsal and ventral outlines are convex. ASPMP3 curves into the anterior side with an upwardly convex curvature that has a centered apex. Both the medial and lateral distal corners are smoothly rugose with mediolaterally oriented attachment fibers. Large foramina border the dorsal and ventral articular margins.

In posterior view, the most notable features are the cartilaginous surface, the soft tissue attachment scarring, and potential osseous cyst-like lesions. Ventrally, there is an upwardly convex surface that is dark and smooth. The surface does not appear to be an articular one, but rather a cartilaginous one with a 65.3 mm mediolateral width and a 24.1 mm dorsoventral height. The rest of the bone is rugose with a large proximal band of posteriorly extended rugose bone that has mediolaterally oriented attachment fibers. Large foramina are beneath the band medially and laterally, but the central bone is smooth from attachment scarring. There are four possible lesional pockets. Two large cyst pockets are on the proximal end, one medially and one laterally. Distally, there are two smaller medial lesions.

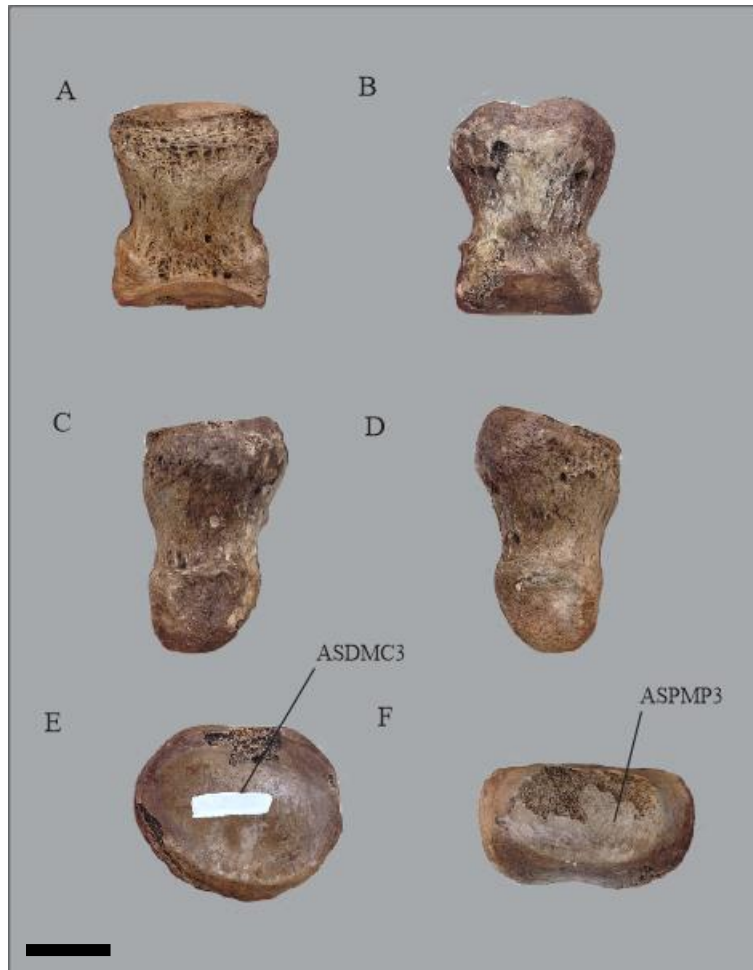


Figure 90: Left proximal phalanx of digit III of UF 256400. A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASPMP3, articular surface to the proximal surface of the medial phalanx of digit III; ASDMC3, articular surface to the distal surface of metacarpal III. Scale bar = 5 cm.

Proximal Phalanx Digit IV. The proximal phalanx for digit IV (PP4) (Figure 91) articulates proximally with the distal surface of Metacarpal IV and distally with the proximal surface of the medial phalanx for digit IV. It is dorsoventrally and mediolaterally elongate and anteroposteriorly narrow. Its greatest dorsoventral length is 112.0 mm; its greatest mediolateral width is 95.0 mm; and its greatest anteroposterior width is 76.0 mm. PP4 is largely complete with only some proximal articular surface weathering and chipping.

In dorsal view, the articular surface that articulates with the distal articular surface on the metacarpal IV (ASDMC4) takes up the entire dorsal view. ASDMC4 is circular and has an anteroposterior length of about 69.0 mm and mediolateral width of about 81.0 mm. The surface is mostly smooth, with no major dark staining or porousness; There is some central dimpling that might have been the start of osteolytic features. Most of the articular border is raised above the surface. There is also a posterolateral rugose projection extending beyond the ASDMC4.

In medial view, the bone is rugose. Posterior outline is greatly concave whereas the anterior outline is only slightly so. Dorsal outline is also concave and the ventral outline is convexly U-shaped. Distally and proximally, most of the soft tissue attachment fibers are anteroposteriorly oriented. Several large foramina are observed in the rugose bone.

In ventral view, the articular surface that articulates with the proximal articular surface of the medial phalanx for digit IV (ASPMP4) is very oblong, oval, and smooth. Its greatest mediolateral width is 72.6 mm and its maximal anteroposterior length is 48.4 mm. There is a raised, lighter colored, central surface that is 38.0 mm in length and 55.3 mm in width. Near the medial edge of the raised surface, there is a small osteolytic pathology. Overall, the whole articular surface is not that porous and stays smooth throughout.

In lateral view, the rugose bone is shaped like its medial sided counterpart; however, there is a larger proximal posterior knot and the distal rugose surface is more extended, all of which causes a deeper concave center in the bone.

In anterior view, the PP4 is curved towards the medial side. Medial outline is concave and the lateral outline is mostly convex except for its central concave channel. Dorsal outline is slightly convex and more proximally extended on the lateral side. Ventral outline appears mostly flat. There are no ridges or knots on the anterior side but the proximal medial corner does have a small anterior extension. Foramina are scattered throughout and rim of the ASPMP4's.

In posterior view, the rugose PP4 has a very pronounced proximal mediolateral ridge that is moderately smooth with only some mediolaterally oriented attachment fibers. Distally, there is a smooth surface where cartilage once was, which is about 66.5 mm mediolaterally wide and 20.0 in dorsoventral height. Much of the surface is smoothly rugose with dorsoventrally oriented attachment strands and very little foramina. Foramina are mostly located near the concave medial and lateral margins. Both the dorsal and ventral outlines are also convex. Proximally, there is a slight circular depression in the rugose band, and distally, there is another but smaller circular depression above the cartilage surface.

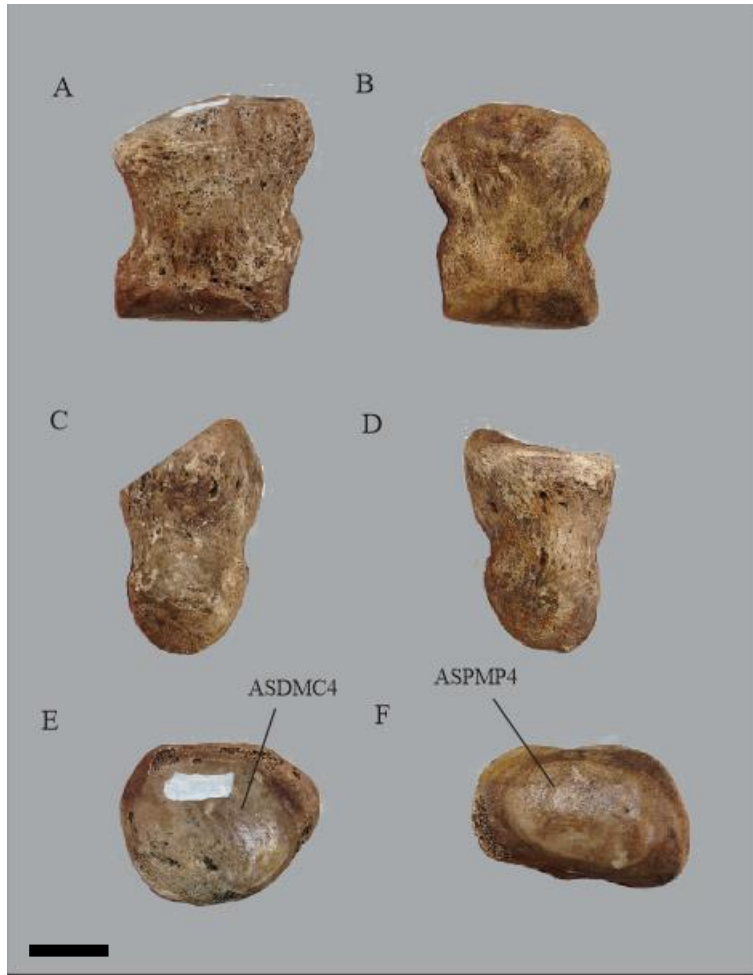


Figure 91: Left proximal phalanx of digit IV of UF 256400. A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASPMP4, articular surface to the proximal surface of the medial phalanx of digit IV; ASDMC4, articular surface to the distal surface of metacarpal IV. Scale bar = 5 cm.

Proximal Phalanx Digit V. The proximal phalanx for digit V (PP5) (Figure 92) articulates proximally with the distal surface of Metacarpal V and distally with the proximal surface of the medial phalanx for digit V. It is dorsoventrally elongate and mediolaterally and anteroposteriorly narrow. Its greatest dorsoventral length is 113.5 mm; its mediolateral width is 86.0 mm; and its anteroposterior width is 73.0 mm. PP5 is mostly complete but has several chipped surfaces.

In dorsal view, the triangular articular surface that articulates with the distal articular surface of metacarpal V (ASDMC5) has medial chipping and encompasses the entire dorsal surface. Mediolateral width of the ASDMC5 is about 70.5 mm and its anteroposterior length was measured at about 69.2 mm. Mediolateral width is less than maximal by a few millimeters due to the chipping. Posterior outline is larger and more straight and the convex medial and lateral sides come to a rounded anterior point. There is an oval depression in the articular surface that runs anteroposteriorly. This surface is rougher than the surrounding articular surface and has a lateral small osteolytic pathology.

In medial view, the dorsal, posterior, and anterior outlines are all concave whereas the ventral outline is convexly U-shaped. The bone is entirely rugose with a more medially extended proximal ridge and distal section within the U-shape curvature. Very few foramina or attachment fibers are visible, and the center of the bone is smooth without the wrinkled rugose texture.

In ventral view, the articular surface that articulates with the proximal articular surface on the medial phalanx for digit V (ASPMP5) is greatly chipped but appeared oval shaped. Articular surface narrowed laterally and the larger medial side has a raised circular surface. Mediolateral length might have been about 55 mm but the chipping is too severe for more accurate length or width measurements.

In lateral view, much of the bone's surface is chipped away. Anterior and posterior outlines are concave; the ventral outline is convexly curved but more V-shaped than U-shaped; and the dorsal outline is flat with the posterior end more proximally extended. Some foramina are seen in the distal rugose bone and there are anteroposteriorly oriented attachment fibers there too.

In anterior view, the PP5 is very distally busted. ASDMC5 is not visible. Medial outline is concave and the lateral outline is convex. Dorsal outline is convex and the ventral outline is concave. The bone is entirely rugose. The center of the bone is smooth without the wrinkled rugose texture. Proximal and distal ends have mediolateral rugose extensions making the smooth center concave between them. Foramina are scattered throughout the surface with few in the center. As a whole, PP5 is medially curved.

In posterior view, the dorsal and lateral outlines are convex whereas the medial and ventral outlines are concave. MP5 is curving medially. Posterior bone is rugose and does not have much of a distal cartilage surface. The bone is laterally and proximally posteriorly extended and is concave distally, beneath the proximal extension. The concave bone has several foramina and above it, into the proximal extension, the bone has several dorsoventrally oriented attachment fibers. Above the proximal extension, the rugose bone is very smooth with no attachment scars or foramina.

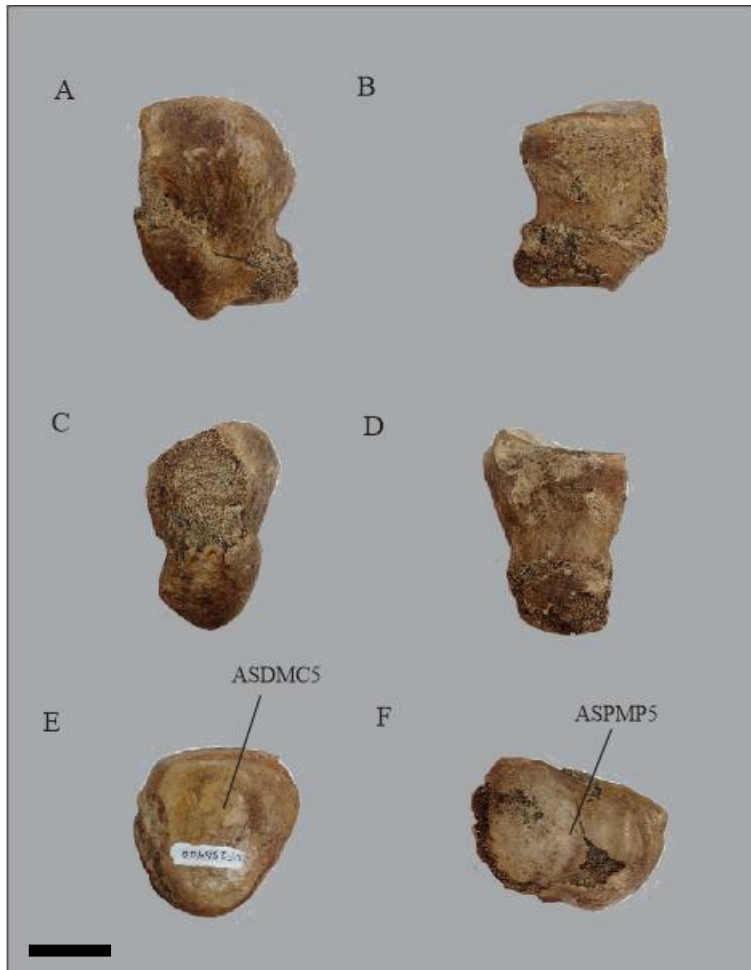


Figure 92: Left proximal phalanx of digit V of UF 256400.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASPMP5, articular surface to the proximal surface of the medial phalanx of digit V; ASDMC5, articular surface to the distal surface of metacarpal V. Scale bar = 5 cm.

Medial Phalanges

Medial Phalanx Digit II. The medial phalanx for digit II (MP2) (Figure 93) articulates proximally with the distal surface of PP2 and distally with the proximal surface of the terminal phalanx for digit II. It is dorsoventrally elongate and mediolaterally and anteroposteriorly narrow. Its dorsoventral length is 72.0 mm; its mediolateral width is 76.0 mm; and its greatest anteroposterior width is 50.0 mm. MP2 is entirely complete.

In dorsal view, the articular surface that articulates with the distal articular surface of the proximal phalanx for digit II (ASDPP2) is the main feature. ASDPP2 is very oval, symmetrical, and concave with the posterior side more elevated than the anterior. It is about 58.7 mm in mediolateral width and 41.6 mm in anteroposterior length. The surface is smooth but porous along the edges and three small pin prick holes in the center. Lateral side of the surface has a slim section that is darker, smoother, and more elevated than the rest of the lighter and rougher surface.

In medial view, the bone is entirely rugose. Dorsal outline is concave with a more elevated posterior edge. Anterior and posterior outlines are also concave, the anterior side more so. Ventral outline is convexly U-shaped. There are no ridges or nodules. Much of the surface is smooth and some small foramina are scattered about. There are also attachment fibers that run from the proximal posterior corner and across and down to the center of the anterior side.

In ventral view, the articular surface that articulates with the posterior articular surface for the terminal phalanx of digit II (ASPTP2) is oval shaped and is only on the lateral side. The wider and more distally extended medial side is non-articular. Greatest mediolateral width of the

ASTP2 is about 33.3 mm, and the greatest anteroposterior length is 23.0 mm. The surface is posteriorly smooth and roughens anteriorly.

In lateral view, the dorsal outline flat and more posteriorly elevated. Posterior outline is convex and the anterior outline is deeply concave. Ventral outline is convexly U-shaped. There is a proximal rugose ridge that starts at the posterior side and extends to the center beneath the dorsal margin. The rugose distal bone is also extended within the U-shaped curvature, and the bone is concave between this and the proximal ridge. Proximal ridge has dorsoventrally oriented attachment fibers and the distal extension has anteroposteriorly oriented fibers. Many foramina are anteriorly located at the proximal end.

In anterior view, the dorsal outline is shaped by the elevated posterior margin to the ASDPP5, which is convex. Ventral margin is concave with the medial corner more distally extended than the lateral. Medial and lateral outlines are more straight than convex and narrow distally. The entire surface is rugose, with many small foramina located beneath the dorsal rim. There is a dark convexly rugose surface near the distal end, potentially for cartilage, and above it there is a large mediolaterally elongated and depressed trench or pit. Many foramina are within the concave pit.

In posterior view, overall shape of the MP5 matches its description of its anterior side, except that the lateral outline has a small depression in its center. There is a slim, dark and smooth surface along the distal margin that was a cartilaginous surface. It is about 45.3 mm in mediolateral width and 9.3 mm in dorsoventral height. Center of the posterior side is smooth and attachment fibers extend from it and to the sides, so some attachments run mediolaterally, dorsoventrally, and diagonally in between the two.

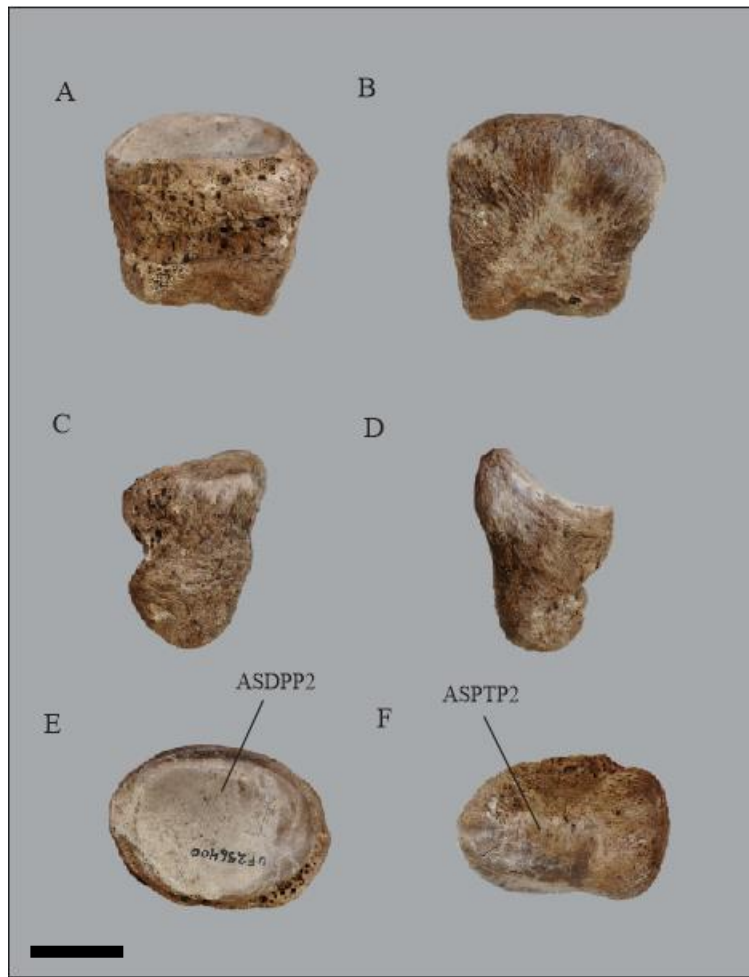


Figure 93: Left medial phalanx of digit II of UF 256400.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASPTP2, articular surface to the posterior surface of the terminal phalanx of digit II; ASDPP2, articular surface to the distal surface of the proximal phalanx of digit II. Scale bar = 5 cm.

Medial Phalanx Digit III. The medial phalanx for digit III (MP3) (Figure 94) articulates proximally with the distal surface of PP3 and distally with the proximal surface of the terminal phalanx for digit III. It is mediolaterally elongate and dorsoventrally and anteroposteriorly narrow. Its greatest dorsoventral length is 64.0 mm; its mediolateral width is 65.0 mm; and its anteroposterior width is 46.0 mm. MP3 is complete with some chipping.

In dorsal view, the articular surface that articulates with the distal articular surface of the proximal phalanx for digit III (ASDPP3) is the main feature. ASDPP3 is very symmetrically oval shaped and deeply concave, with the posterior side more elevated than the anterior. It is about 38.3 mm in mediolateral width and 57.3 mm in anteroposterior length. The surface is most smooth but posteriorly porous. Articular border is raised above the articular surface. A slim strip of rugose bone extends all around the articular surface.

In medial view, the bone is entirely rugose. Dorsal outline is concave with a more proximally extended posterior edge. Ventral outline is convexly rounded and U-shaped. Anterior outline is more concave than the posterior side. There is a rugose ridge that runs from the proximal posterior margin across and down to the anterior distal margin. Foramina are small and few.

In ventral view, the articular surface that articulates with the posterior articular surface for the terminal phalanx of digit III (ASTP3) is symmetrically circular. Mediolateral width of the ASTP3 is about 34.9 mm and the anteroposterior length is 18.9 mm. Center of the ASTP3 has a small circular depression. ASTP3 is concave and slightly porous.

In lateral view, the rugose bone strongly mirrors its medial sided counterpart. Dorsal outline is still concave with a more proximally extended posterior edge and the ventral outline is

still convexly U-shaped. Posterior outline is flat and the anterior outline is strongly concave in its center. There is a rugose ridge that runs from the proximal posterior corner down and across to the distal anterior corner. Proximally, attachment fibers run dorsoventrally and distally, the fibers run anteroposteriorly. Several foramina are scattered about.

In anterior view, the MP3 is very symmetrical. Dorsal outline is shaped by the elevated posterior margin to the ASDPP3, which is convex. Ventral margin is flat and the medial and lateral outlines are convex. The entire surface is rugose with many foramina. There is a proximal mediolateral ridge. Distally, there is a concave, oval pit in the center above the ventral margin that is smooth and lacking foramina. The center of the bone is concave between these two features.

In posterior view, the MP3 is very symmetrical. Dorsal outline is convex, the ventral and medial outlines are flat and straight, and the lateral outline is flat but slants inwards from the proximal lateral corner down to the distal lateral corner. The entire surface is very smooth and the proximal margin is rugose with dorsoventrally oriented soft tissue attachment scarring. A few foramina are beneath the scars, especially a large central one. Distally, there is a dark and smooth surface for cartilage that extends flatly mediolaterally.

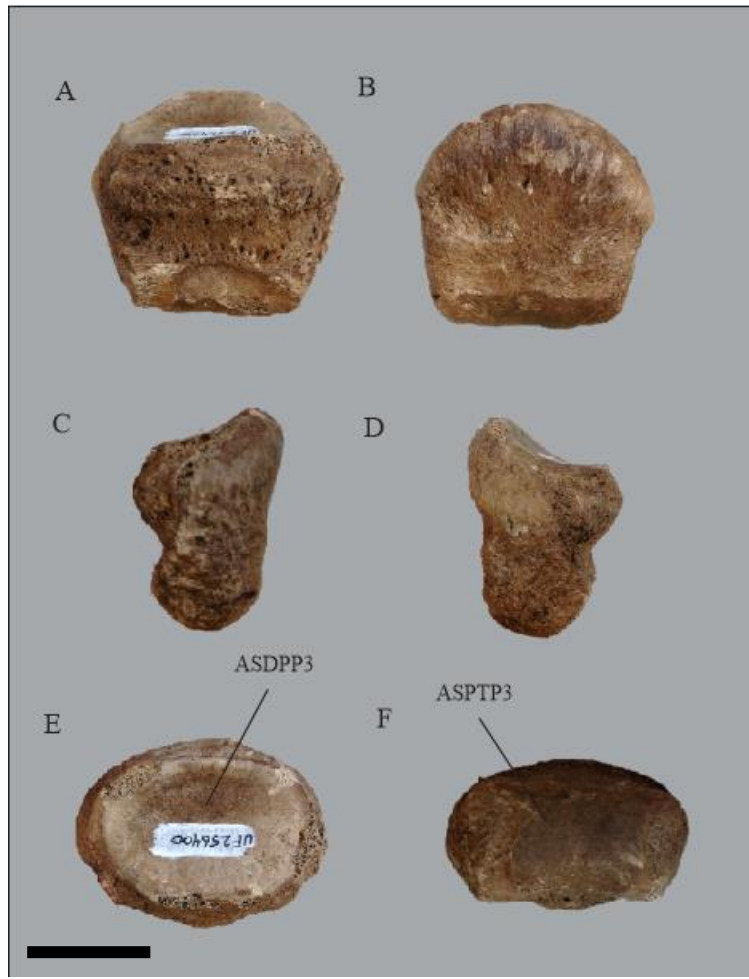


Figure 94: Left medial phalanx of digit III of UF 256400.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASPTP3, articular surface to the posterior surface of the terminal phalanx of digit III; ASDPP3, articular surface to the distal surface of the proximal phalanx of digit III. Scale bar = 5 cm.

Medial Phalanx Digit IV. The medial phalanx for digit IV (MP5) (Figure 95) articulates proximally with the distal surface of PP4 and distally with the proximal surface of the terminal phalanx for digit IV. It is mediolaterally elongate and dorsoventrally and anteroposteriorly narrow. Its dorsoventral length is 73.0 mm; its mediolateral width is 72.0 mm; and its greatest anteroposterior width is 45.0 mm. Anteroposterior length is less than maximal due to anterior chipping. Medial phalanx for digit IV, or MP4, is mostly complete, with some chipping.

In dorsal view, the articular surface that articulates with the distal articular surface of the proximal phalanx for digit IV (ASDPP4) is the main feature. ASDPP4 is oval shaped and porous. Its anteroposterior length is 37.5 mm, which is less than maximal due to chipping along the anterior rim. Mediolateral width is 62.8 mm. The surface is concave with the posterior side more proximally elevated than the anterior. There are also two osteolytic features, one large and one small, lateral of the center. Posterior and medial articular rims are elevated above the articular surface, but the lateral border is flush with it. Anterior border is missing due to chipping. Some rugose bone extends medially beyond the articular surface.

In medial view, the bone is entirely rugose. Dorsal and anterior outlines are concave, and the posterior side is mostly flat. Ventral outline is convexly U-shaped. Some proximal rugose surface is chipped centrally and anteriorly. There is a rugose protrusion that starts at the proximal posterior corner and ends with the chipped central surface. Distally, there is an anteroposterior band of rugose bone that has similarly oriented attachment fibers. Foramina are small and few.

In ventral view, the articular surface that articulates with the posterior articular surface for the terminal phalanx of digit IV (ASTP4) is oval and greatly chipped. The preserved surface and chipping outline hints that the surface was oval, and much of the preserved surface is rough,

especially centrally. Estimated measurements are as follows: the mediolateral width of the ASTP4 is about 33.3 mm and the anteroposterior length is 23.0 mm.

In lateral view, the rugose bone is distally chipped. Dorsal outline is strongly concave and the anterior and posterior outlines are only slightly concave at the centers. Ventral margin appears to be convex, and most likely U-shaped. The bone is entirely rugose but smooth. There is also a proximal posterior extension, though not quite a ridge or nodule. Foramina are absent.

In anterior view, much of the proximal medial to center surface is chipped away, and the distal lateral to center surface is also chipped. Dorsal outline is shaped by the elevated posterior margin to the ASDPP4, which is convex. Ventral margin is concave. Medial outline is slightly convex and the lateral outline is slightly concave. Ventral outline, with what is present, appears moderately flat with the medial corner more distally extended than the lateral corner. The entire surface is rugose and there is a mediolaterally elongated and depressed trench or pit in the center. Many foramina are in the proximal margin of this concavity. Preserved distal medial corner appears smoothly rugose with mediolaterally oriented attachment fibers.

In posterior view, the dorsal outline is convex, the lateral outline is concave, the medial outline is almost straight but with the slightly convex center, and the ventral outline appears flat with the medial corner more distally extended than the rest of the margin. There is a hint of a smooth and dark cartilage surface but much is chipped away and cannot be measured. The rest of the bone is rugose with attachment fibers starting at the center and crossing up to the dorsal margin. There is one foramen in the smooth center.

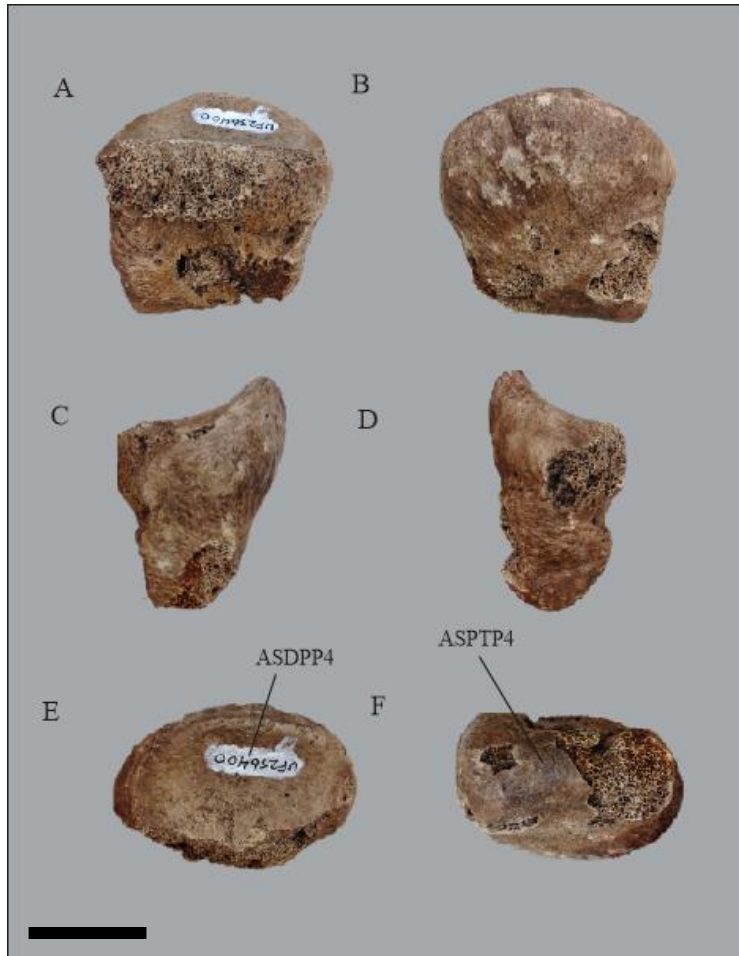


Figure 95: Left medial phalanx of digit IV of UF 256400.

A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASPTP4, articular surface to the posterior surface of the terminal phalanx of digit IV; ASDPP4, articular surface to the distal surface of the proximal phalanx of digit IV. Scale bar = 5 cm.

Terminal Phalanges

Terminal Phalanges Digit I, II, IV, & V. These terminal phalanges are missing.

Terminal Phalanx Digit III. The terminal, or distal, phalanx for digit III (TP3) (Figure 96) articulates posteriorly with the distal articular surface of the medial phalanx for digit III. It is dorsoventrally elongate and mediolaterally and anteroposteriorly narrow. Its mediolateral width is 55.0 mm; its greatest anteroposterior length is 46.0 mm; and its greatest dorsoventral length is 65.0 mm. Dorsoventral length may be less than maximal by a few millimeters due to a partially missing distal end. TP3 is mostly complete but it is missing a section of bone anteromedial section, which includes the partially missing distal medial side. In overall shape, the terminal phalanx is very similar to the medial phalanges except that its distal end is roundly pointed with no articular surface.

In dorsal view, the main feature is the articular surface that articulates with the distal articular surface of the medial phalanx for digit III. This articular surface (ASPTP3) is very circular, almost symmetrical, rough, and porous with numerous small nodules on its surface. Its anteroposterior length is 50.3 mm and its mediolateral width is 43.5 mm. ASPTP3 is concave and the posterior margin is more proximally elevated than the anterior side. There is also a large osteolytic pathology just anterior of its center. Most of the surface is lightly colored but the anterior and lateral articular surface areas are darkly colored and more porous than the rest of the surface. At the anterolateral curvature, there is also a circular and depressed pocket of articular surface.

In medial view, the dorsal outline is concave, with a more proximally extended posterior edge, and the anterior outline of the TP3 is also greatly concave. Ventral outline is convex and most of the posterior outline is convex except for the slightest inward dip in the center of the

posterior curvature. TP3 narrows distally to a ventral point. The entire medial side of the TP3 is rugose but without any extended ridges or nodules. Only a few small foramina are visible.

In ventral view, the rounded ventral tip is the main feature but the proximal anteriorly extended bone is visible beyond the ventral point. Much of the anterior surface and the medial side of the ventral surface is missing, so interior cancellous bone is also visible. Regardless, the ventral point is rugose, without an articular surface and with a few small foramina visible.

In lateral view, the outlined shape of the bone strongly mirrors the medial side. Dorsal outline is concave, with a more proximally extended posterior edge, and the anterior outline of the TP3 is greatly concave. Ventral outline is convex and the posterior outline is convex, but without a slight inward dip in the center of the posterior curvature. TP3 narrows distally to a ventral point. The entire medial side of the TP3 is rugose but without any extended ridges or nodules. Only a few small foramina are visible. Several soft tissue attachment fibers are visible, some running anteroposteriorly near the dorsal margin and others running dorsoventrally from the extended posterior edge down to the distal anterior corner.

In anterior view, much of the medial side of the TP3 is missing but several distinct features are apparent in the lateral to central areas. The entire anterior side is rugose bone. Proximally, the mediolateral width of anterior surface is anteriorly extended, with several foramina. Beneath the proximal rugose ridge, there is a central concavity with several larger foramina, and distally, the bone extends anteriorly again but not to the same extent as the proximal ridge. From the lateral side of the bone, several of the anteroposteriorly oriented attachment fibers are curving into the anterior side, becoming mediolaterally oriented attachment fibers. These attachment strands do not occur in the central concavity. Overall, the shape of the

P3 in anterior view is triangular, with the slight convex dorsal outline making the base and the rest of the bone distally and convexly narrowing to a rounded point.

In posterior view, the TP3 is more oval in shape, narrowing distally. The rugose surface is more wrinkled in appearance, with attachment scarring, on the lateral side but the lack of rugose texture on the medial side could be due to weathering. The more distal portion is darker in color, with no attachment features, and has very small foramina.

Sesamoids

There are several sesamoids for the left manus, although their articulation points are unknown. All the sesamoids are either the typical teardrop or oval shape. Many have the articular surface on their medial sides where they articulated with a medial or lateral pair.

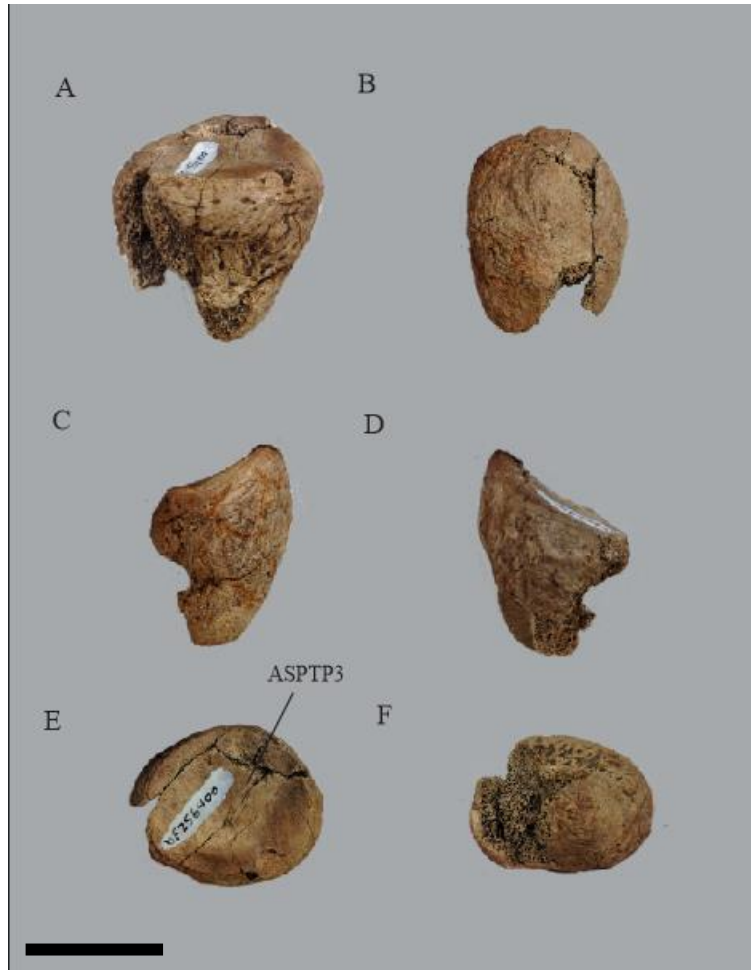


Figure 96: Left terminal phalanx of digit III of UF 256400. A, anterior; B, posterior; C, lateral; D, medial; E, dorsal; and F, ventral. ASDMP3, articular surface to the distal surface of the medial phalanx of digit III. Scale bar = 5 cm.

CHAPTER 8. RESULTS

Carpal Comparisons

Pisiform

Of the five different proboscideans compared here, only four pisiforms were available for study, and of the four pisiforms, only three were complete. The pisiform for ETMNH 305 was very broken, missing its entire proximal end, and UF 137891 was missing its entire pisiform. UF 69997, UF 423090, and UF 256400 had complete pisiforms. There is not much variation between the pisiforms. Their differences are mostly observed at their articular surfaces, and degree of curvatures. ASU3 is oval for UF 256400, tear drop shaped and more anteriorly narrow for UF 69997, triangular and anteriorly narrow for 423090, and unknown for ETMNH 305. ASC4 for UF 256400 and UF 423090 have more circular shaped articular facets that distally extend and widen towards the posterior curvature. UF 69997 has a long and slender oval articular surface that stays along the proximal edge but also widens posteriorly. The ETMNH 305 is indeterminate for its proximal features. Furthermore, the concave curvature on the anterior side of the bone is also greatest in UF 423090, followed by 69997, and UF 256400. Once again, ETMNH 305 has an indeterminate curvature. The only other variations occur with the placements of the rugose ridges, nodules, or depressions. UF 69997 has the most of these rugose features, followed by UF 256400, and then the 423090. ETMNH 305 remains indeterminate on the number of rugose features it had.

Cuneiform

ETMNH 305's cuneiform is very similar to UF 137891. The only significant differences between the two is the distal facet on the medial side and the proximal curvature of the ventral

side's articular surface onto the anterior side. ASL is proportionally larger on UF 137891 and extends from the anterior side to the posterior, narrowing posteriorly. ETMNH 305's ASL is smaller and terminates in the center of the medial side, not extending to the posterior edge. Also, the ASUN curves onto the anterior side of the cuneiform greatly in ETMNH 305 along the lateral projection, but this barely occurs on the UF 137891.

Between ETMNH 305 and UF 69997, they differ with the articular surfaces on the medial side and the articular surface on the posterior side. ASL on UF 69997 starts in the center and extends to the posterior side, without much narrowing, whereas ETMNH 305's ASL is only on the anterior side and narrows and terminates in the center. Also, there is a proximal articular surface, caused by the distal curvature of the ASU onto the medial side, that ETMNH 305 lacks. The proximal articular surface extends the anteroposterior width. On the posterior side, the ASP is proportionally much larger than ETMNH 305's ASP, although their shapes are similar. ASP on ETMNH 305 extends laterally within the lateral projection, but UF 69997 does not follow the projection's point, instead extending laterally over it. Concavity beneath the ASP on UF 69997 extends beneath the entire articular surface but is only medially concave, and more concave, on ETMNH 305. Proximal curvature of the ASUN on the anterior side is similar to ETMNH 305.

In comparison with UF 423090, the differences occur at the same articular surfaces. On the medial side, UF 423090 has a centered ASL that narrow and terminates towards the posterior and anterior sides. It also has a distinctive proximal articular surface caused by distal curvature of the ASU, unlike ETMNH 305. On the posterior side, the ASP is more oval rather than triangular like on ETMNH 305, and the same concavity occurs beneath the small gomphothere's ASP as it does in UF 69997. Proximal curvature of the ASUN on the anterior side is similar to the ETMNH 305.

UF 256400's cuneiform is much more squat in overall shape. It is much thicker but also shorter in mediolateral width, with a strongly posteriorly curved lateral projection. ETMNH 305 has a longer mediolateral width with a more gently posteriorly curved lateral projection. The medial side of UF 256400 has an ASL like UF 137891, and a proximal articular surface like UF 69997 and UF 423090. UF 256400 is similar to ETMNH 305 in ASP shape, orientation, and distal concavity and in the ASUN proximal curvature onto the anterior side.

Lunar

Of the five proboscideans, there are only four complete lunars, and UF 423090 is missing its lunar. In comparison with UF 137891, the main differences occur with the articular surfaces on the medial and lateral sides. On the medial side, UF 137891 has an anteroposteriorly wider facet that extends closer to the posterior end. ETMNH 305's distal articular surface is only along the anterior area. Also, the proximal articular surface is much more dorsomedially extended than UF 137891's. On the lateral side, the proximal articular surface on ETMNH 305 has a central proximally convex dip that nearly separates the articular surface into two separate articular surfaces, which is not the case for the proximal articular surface for UF 137891. The distal and more posterior concave curvature of UF 137891's lunar is much more pronounced than ETMNH 305's.

The lunar for UF 69997 has similar differences like UF 137891. The distal articular surface on the medial side is very long, more so than UF 137891's, extending from the anterior edge almost to the posterior. Also, the proximal articular surface is even more dorsomedially extended than ETMNH 305's, causing a triangular point along the dorsomedial margin in anterior view, which ETMNH 305 does not have. In lateral view, the proximal articular surface is like the UF 137891's, without the ETMNH 305's central near separation; however, like

ETMNH 305 and unlike the UF 137891, the distal and more posterior concave curvature is gently sloped.

UF 256400 is very similar to ETMNH 305. Besides the overall thickness of the bone, the main difference is the proximal articular surface on the lateral side. The proximal articular surface is large and oval, narrowing anteriorly, instead of being long and slender and almost split like the ETMNH 305's. The posterior protrusion is centered on ETMNH 305 and more distally located on UF 256400.

Scaphoid

The scaphoid for uf 423090 is missing, leaving only four complete scaphoids for comparison. ETMNH 305 has a scaphoid very similar to UF 137891's. Overall, the UF 137891's scaphoid is much more triangular in shape whereas ETMNH 305's is very rounded. On the medial side, there is a small proximal articular surface that is formed by the dorsal articular surface extending distally into the medial side. This surface is much larger in UF 137891 and is very slim in ETMNH 305. Also in medial view, the distal articular surface does not have an articular surface bordering it in the UF 137891, unlike ETMNH 305. For ETMNH 305's scaphoid, the articular surface on the ventral side curves proximally to border, and even extend past, the distal articular surface on the medial side.

For UF 69997, several of the same differences mentioned above apply. For instance, the overall shape is very sharply triangular, more so than UF 137891's scaphoid shape. The proximal articular surface is also larger on UF 69997 than ETMNH 305; however, the two distal articular surfaces are similar to ETMNH 305 with the exception that the ventral articular surface does not extend proximally past the medial side's distal articular surface. The articular surface on the

ventral side is very long and slender in UF 69997 and very wide and shorter in ETMNH 305. Rugose bone extends beyond the articular surface in ETMNH 305 but not UF 69997.

UF 256400 scaphoid is different from those of the other taxa, largely in part because it split into two different bones that articulate together to form an extra large “scaphoid”; however, this splitting is not typical of mammoth scaphoids and is simply unique to this individual. There is also a large, circular proximal articular surface on the medial side, that is entirely separate from the dorsal articular surface, which none of the other scaphoids display. Like ETMNH 305, the ventral articular surface proximally curves up beside the medial side’s distal articular surface and extends proximally beyond it. The ventral articular surface is like UF 69997 and UF 423090 in shape and size.

Unciform

All five proboscideans have complete unciforms for comparisons. The unciform for UF 137891 is not similar to t ETMNH 305 in any view except anterior and posterior. The medial and lateral outlines of UF 137891 in dorsal view are concave whereas ETMNH 305 has more convex medial and lateral outlines. The anterolateral corner is also rugose in ETMNH 305 whereas the entire dorsal surface is articular in UF 137891. In medial view, the distal articular surface in ETMNH 305 is very long and slender and nearly nonexistent in UF 137891, only located anteriorly. In ventral view, only the articular surface for the MC4 is in prominent view in ETMNH 305, whereas the articular surfaces for the MC3, MC4, and MC5 are in view on UF 137891. The lateral sides between the two mastodons are similar except that ETMNH 305 has an anterior nodule that the articular surface curves behind, whereas UF 137891 lacks the nodule so the articular surface is flush with the articular side.

Unciform for UF 69997 is also very similar to UF 137891, having all the same differences between it and the ETMNH 305. Although both UF 137891 and UF 69997 unciforms are lefts, the difference between them is that when they are both in ventral view, they look like mirrors of each other. The articular surface for the third metacarpal is the largest, downsizing to the central fourth metacarpal articular surface, and the articular surface for the fifth metacarpal is the smallest. This is reverse for the UF 137891.

For UF 423090, the medial and lateral sides in dorsal view are concave whereas ETMNH 305's medial and lateral sides are mostly convex, but they both have a rugose anterolateral corner. In medial view, the UF 423090 has a long and slender proximal articular surface that connects with the larger distal articular surface. ETMNH 305 has a very large proximal articular surface and a long slender distal articular surface that do not touch and have a large gap between the two surfaces. In ventral view, UF 423090 is like UF 137891 and UF 69997. UF 423090 does not have the rugose knot near the anterior side in lateral view that ETMNH 305 has.

UF 256400 unciform's is differently shaped than the rest of the unciforms by having convex sides and a small, rounded posterolateral extension with rugose bone extended beyond it. The rugose bone beyond the articular surfaces are usually centered. In medial view, UF 256400 is very similar to ETMNH 305 except that the posterior end of the proximal articular surface is more rounded, and the anterior side is flatter in ETMNH 305. UF 256400's ventral surface is like UF 137891. The rugose knot on the lateral side is also larger in UF 256400, pushing the articular surface for the fifth metacarpal closer to the posterior margin than in ETMNH 305.

Magnum

All five proboscideans have a complete magnum for comparisons. The overall shape of the magnum in dorsal view is slightly variable between ETMNH 305 and the UF 137891. The medial side is flatter in UF 137891 and slightly convex in ETMNH 305, and the anterior side is also flatter versus ETMNH 305's convex anterior outline. The lateral outline of UF 137891 is much more concave than ETMNH 305's. In lateral view, their articular surfaces are roughly the same in shape except for the distal portion. Distally, the articular surface in ETMNH 305 is one single, proximally convex and slim surface that narrows and terminates posteriorly. In UF 137891, the distal articular surface is greatly concave in the center, nearly separating the surface into two, and the posterior portion is large and triangularly rounded.

In medial view, the two mastodons are moderately similar in articular surface shapes and size. The only differences are that the anterior end of the proximal articular surface in UF 137891 is large and rounded and touches the distal articular surface. For ETMNH 305, the anterior portion of the proximal articular surface is narrow and flat, with a large concave rugose gap between it and the distal articular surface. In ventral view, they two mastodons are also very similar with only two small differences. The central articular surface is convexly rounded and posteriorly extends beyond the lateral articular surface, whereas UF 137891's central articular surface is squarely rounded, and the lateral articular surface extends beyond posteriorly beyond it. The lateral articular surface is also more proximally slanted towards the lateral side of the magnum for t ETMNH 305 but is much less proximally slanted in UF 137891.

With comparison to UF 69997, some of the shape outlines in dorsal view differ from ETMNH 305. Like UF 137891, the medial outline is flatter than ETMNH 305's and the lateral side is also much more concavely curved. The posterior outline has its convex apex in the center unlike ETMNH 305's magnum, which has it at the medial corner. On the lateral sides, UF 69997 and ETMNH 305 are similar except that UF 69997's magnum does not have a distal portion of the lateral articular surfaces, only a proximal and anterior. The medial side of UF 69997's magnum is very similar to UF 137891's magnum. The anterior end of the proximal articular surface is large and rounded and touches the distal articular surface. The distal articular surface is only anteriorly oriented, unlike ETMNH 305's magnum that extends to the posterior side.

UF 423090's magnum also has several differences from ETMNH 305. The lateral side in dorsal view of UF 423090's magnum is greatly concave and the posteromedial corner is greatly extended medially. On the lateral side, UF 423090 is like UF 69997, without a distal portion of the lateral articular surfaces. On the medial side, the UF 423090 magnum does not have a distal articular surface, unlike ETMNH 305's magnum. In ventral view, the lateral articular surface for UF 423090 is barely viewable, having a strong proximal slant to the lateral side.

UF 256400's magnum is very different from t ETMNH 305's magnum and the other proboscidean magnums. In dorsal view, it is saddle shaped, with concave medial and lateral outlines and mirrored anterior and posterior outlines. On the lateral side, UF 256400's magnum has separate proximal and distal articular surfaces, unlike ETMNH 305's magnum. The distal articular surface is chipped away, hindering its shape and size determination, and the proximal articular surface is nearly divided into two separate proximal articular surfaces, unlike ETMNH 305. On the medial side, UF 256400's distal articular surface is also chipped away, but the chipping outline appears to match the size and shape of the ETMNH 305's. The proximal

articular surface is also virtually the same shape as the ETMNH 305's but is much wider, leaving a smaller rugose gap between the two articular surfaces than ETMNH 305's magnum.

Trapezoid

UF 423090 does not have a trapezoid but the other proboscideans do, leaving four complete trapezoids for comparison. UF 137891's trapezoid has several differences from ETMNH 305's trapezoid. In dorsal view, the lateral outline is convex in UF 137891 instead of flat as it is for ETMNH 305's trapezoid. On the lateral side, there is only one large, square articular surface anteriorly, which is different from the wedge-shaped articular surface that stretches most of the anteroposterior length on the lateral side of ETMNH 305's trapezoid. On the medial side of UF 137891's trapezoid, the articular surface is largely the shape of a lowercase r with a small distal articular extension that rounds into a circular posterior facet. For ETMNH 305's trapezoid, the main r-shaped articular surface has a small distal finger of articular surface that does not have an expanded posterior facet. The articular surface on the ventral side of ETMNH 305's trapezoid is much wider, without a narrow central area like the UF 137891's trapezoid.

With comparison to UF 69997, ETMNH 305 has a flat lateral side, not a concave one. The articular surface on the lateral side is also triangular wedge shaped and not shaped like a lowercase r as it is for UF 69997. The articular surface on the ventral side is also wider, especially posteriorly, in ETMNH 305 and not as slim as in UF 69997. The medial side of UF 69997 has the main r-shaped articular surface but does not have the distal extension that ETMNH 305 and UF 137891 have.

UF 256400's trapezoid, like most of the other trapezoids, has a concave lateral side instead of a flat one like ETMNH 305's trapezoid. The somewhat r-shaped articular surface on the lateral side is only in the center of the bone instead of being along the anterior and extending to the posterior like ETMNH 305, UF 137891, and UF 69997 trapezoids. The medial side has two separate proximal articular surfaces instead of one, and no distal articular surface, like ETMNH 305's trapezoid. UF 256400's articular surface on the ventral side is also the slimmest of all the trapezoids, whereas ETMNH 305's trapezoid has the broadest.

Trapezium

There are only four trapeziums, with UF 423090 missing its trapezium. UF 137891's trapezium is perhaps the closest in similarity to ETMNH 305's trapezium. Its articular surface on the dorsal side is very small, rounded, and concave whereas ETMNH 305's trapezium has a very large, triangular, and flat articular surface. The articular surface on the medial side is also flat, large, and triangular for ETMNH 305's trapezium but is very oval shaped in UF 137891 and is proportionally larger with a small portion that distally curves onto the ventral side, acting as a small, concave facet. Both have circular articular surfaces on the lateral side.

The trapezium for UF 69997 has four main articular surfaces, unlike ETMNH 305's trapezium, which only has three. They both have a similar shaped and sized flat articular surface on the dorsal side; however, the medial side has a circular articular surface on UF 69997 and a triangular on ETMNH 305's trapezium. An articular surface is also present on the ventral side that connects with the articular surface on the medial side. This circular articular surface is not present on ETMNH 305, and a hint of this surface might be present on UF 137891. The articular surface on the lateral side is very large and oval, not round as it is in ETMNH 305's trapezium.

Where ETMNH 305's trapezium has three main articular surfaces, UF 256400 has four but it appears to have a developing fifth. It has a large, concave and oval articular surface on the dorsal side, a large circular articular surface on the ventral side, a large oval articular surface on the lateral side, and a large, concave, oval shaped articular surface on the medial side. The articular surface on the medial side has an extension that depresses from it and appears to be on the anterior side. The extension is curved like this to fit with the concave curvature of the lateral side of the trapezoid that it articulates with.

Metacarpal Comparisons

Metacarpal I

All the MC1s are present except for UF 423090's MC1, which is missing. All of the MC1s are similar except for one major difference. The articular surface for PP1 is in line with the articular surface on the dorsal side in all the proboscideans except ETMNH 305's MC1. For ETMNH 305, the articular surface for PP1 is oriented at a 45° medially.

Metacarpal II

In dorsal view, ETMNH 305's MC2 is different from the rest. ETMNH 305's MC2 has the ASTD2 as the larger articular surface, with a straight connective margin separating it from the ASLM. The opposite is true for both UF 137891 and UF 256400; however, UF 69997 and UF 423090 have larger ASTD2s as well but with much more reduced ASLMs and a greatly curving connective margin between them. On the lateral side, the UF 256400 and UF 69997 have small, circular, and proximal anterior articular surfaces whereas UF 137891 and UF 423090 have a slim and fully extended anteroposterior proximal surface. ETMNH 305 has no proximal surface on the lateral side.

Metacarpal III

In dorsal view, ETMNH 305's MC3 is most similar to UF 69997 and UF 423090, which both have a large, broad ASM4 and a smaller ASUN3. UF 256400's ASM4 is slim, as is the ASUN3. For UF 137891, the two articular surfaces are almost equal in size, with a very centrally oriented connective margin, whereas the other connective margins are much more laterally located.

Metacarpal IV

The MC4 is missing for ETMNH 305 and UF 423090 but available for the other proboscideans. There are only a few subtle differences between UF 256400, UF 137891, AND UF 69997 MC4s. In dorsal view, the proximal articular surface on the medial side is visible for UF 256400 and UF 137891, but not for UF 69997. The main difference is curvatures of the proximal articular surfaces on the medial and lateral sides. They are distally convex in UF 256400 and UF 137891 but are both concave in UF 69997.

Metacarpal V

The MC5 for UF 423090 is missing and the MC5 for UF 69997 is too fragmented for proper comparison, but ETMNH 305, UF 137891, and UF 256400 MC5s are available and whole. One slight difference between them is based on the proximal articular surface on the medial side. It is long and slender in UF 137891. For ETMNH 305, the articular surface is much thicker dorsoventrally. In UF 256400, it is more oval and centered. Also, in dorsal view, the ASUN4 is oval in UF 137891, more circular in UF 256400, and more triangular in ETMNH 305.

Phalange Comparisons

There are no phalanges for either UF 423090 or UF 69997. Between ETMNH 305, UF 137891, and UF 256400, the proximal phalanges are extremely similar with the most noticeable differences being the shape of the articular surfaces for the distal ends of the metacarpals. These articular surfaces on the dorsal side can be oval, round, and even heart shaped, and more than one shape can occur within the set. With these three individuals, ETMNH 305 had more oval shaped surfaces whereas UF 137891 had oval and heart shaped surfaces. UF 256400 had more circular surfaces and there is also a proximal central depression within the rugose surface on the posterior side that is not present in either ETMNH 305 or UF 137891. There is even less differences amongst the medial phalanges. The main two subtleties that can be seen is that ETMNH 305's medial phalanges have larger distal surfaces on the posterior side for cartilage than either UF 256400 or UF 137891. Also, the posterior sides of UF 256400 have a significantly greater amount of soft tissue attachment scarring.

Perhaps the greatest differences in phalanges occurs in the distal or terminal phalanges, of which there is only the TP3 for ETMNH 305 and UF 256400. The TP3 for ETMNH 305 is a tripartite phalanx with bilateral wing lucencies. It attaches to the distal end of MP3 and extends straight from it with no curvature. UF 256400's TP3 looks very much like a smaller MP but without a distal articular surface. It attaches to the distal end of MP3 and curves from it.

Sesamoid Comparisons

There are no significant differences between the sesamoids of the different proboscideans. The sesamoids are small, round, oval, and tear drop shaped bones that articulate with the distal medial and lateral articular surface on the metacarpals posterior sides and are

always in pairs. Occasionally, sesamoids can fuse, which is what occurred for the pair articulated with ETMNH 305's MC1. Besides general size, each sesamoid is variable and has no bearing on taxa distinctions.

CHAPTER 9. DISCUSSION & CONCLUSIONS

Morphological Description

Manus morphology of ETMNH 305 is indeterminate for classifying genera; however, it shares many manus similarities with UF 137891, UF 69997, and UF 423090 more so than it does with UF 256400. This could mean there were taxon-related differences in habitat or locomotion. Its manus height is also taller, and slightly more gracile, than of *Mammut americanum*, which coincides with ETMNH 305 having taller and more gracile limbs than most *Mammut*. Because there is only one complete GFS mastodon skeleton excavated and prepped, besides isolated elements from other individuals, it is beyond the scope of this study to try and determine ontogenetic or sexual dimorphic variables within the manus of this proboscidean population.

ETMNH 305 has a very splayed manus, more so than UF 137891 as seen in digit I. The phalanges attached to MC1 are oriented at a lateral 45°, which allows the manus to have an overall wider, and flatter structure for stability. Compared to the other proboscidean taxa where digit I is more elevated in the fat pad, ETMNH 305's digit I is a more active digit, connecting more firmly with the ground, with very large and flat MC1 articular surfaces for proximal and anterior extensions during compression. MC2 also does not have a lateral connection with MC1, further demonstrating the lateral extension MC1 exhibits and the lack of an articular limit for a narrow range of movement. The distal structures of the lateral digits experience high pressures or mechanical stresses during locomotion (Panagiotopoulou et al. 2012). ETMNH 305 counters this by having the lateral digits extend just as distally as the rest of the digits, and they also have a large anterior distal extension, though not to the same extent as the medial digits. All five digits basically act as supports, and the stresses are more equally applied with each digit having a

nearly equal splayed distance and dorsoventral distal connection. Similar traits are seen in other mastodons, except for the MC1 45° orientation, but are more exaggerated in ETMNH 305.

Whereas it appears that the lateral digits have more mobility than in the UF proboscideans with their large and flat articulations, the medial digit III seems to have the least ability for movement, acting as a central mainstay pillar. With digit III and the carpals, the midline of the manus is very interlocked and strong while still allowing a great deal of wrist movement, perhaps more so than the other proboscidean taxa. There is no midline that is usually seen running down between the cuneiform and lunar and their underlying unciform and magnum carpal pairs. This midline is apparent in the UF proboscideans, is common in other museum proboscideans, and is also a trend in *Mammuthus meridionalis*; but the midline is not visible in ETMNH 305. This midline is known as a serial carpal alignment and although it is prominent in *M. meridionalis*, other mammoths exhibit an aserial carpal arrangement (Lister 1996). *Mammuthus trogontherii*, which is an intermediate link between *M. meridionalis* and *Mammuthus primigenius*, has an aserial carpal arrangement that continues for the rest of the lineage (Lister 1996). Both *M. meridionalis* and *M. trogontherii* were tall, with *M. trogontherii* being as large or slightly larger; respective heights have been recorded at >370 and 450 cm (Lister 1996). Perhaps serial carpal arrangement is an adaptation to a height advancement.

ETMNH 305 has an aserial carpal arrangement like mammoths and has an estimated shoulder height between 320 and 350 cm (Widga pers. comm. 2019). The medial line between the cuneiform and lunar is underlined by the medial corner of the unciform and the medial line between the unciform and magnum is beneath the lunar. This interlocked pattern continues towards digit I with the medial line between the magnum and trapezoid also beneath the lunar and the medial line between the lunar and scaphoid are above the center of the trapezoid. These

interlocked carpals add strength to the forefoot for general weight support and splaying expansion, and the large flat articular surfaces between the medial lines increase anteroposterior and dorsoventral flexion within the wrist. The extra support and splaying capabilities in the manus could possibly be present due to the terrain and size of the mastodon. Landscape protrusiveness may have something to do with foot morphology. Probably due to the soft and steep substrate, the TP3 is adapted to an anteriorly pointed tripartite phalanx with bilateral lucencies. This TP is the last foot element to lift off the ground and so the extra point and ligament anchored bilateral lucencies provide a final digging grip into the ground.

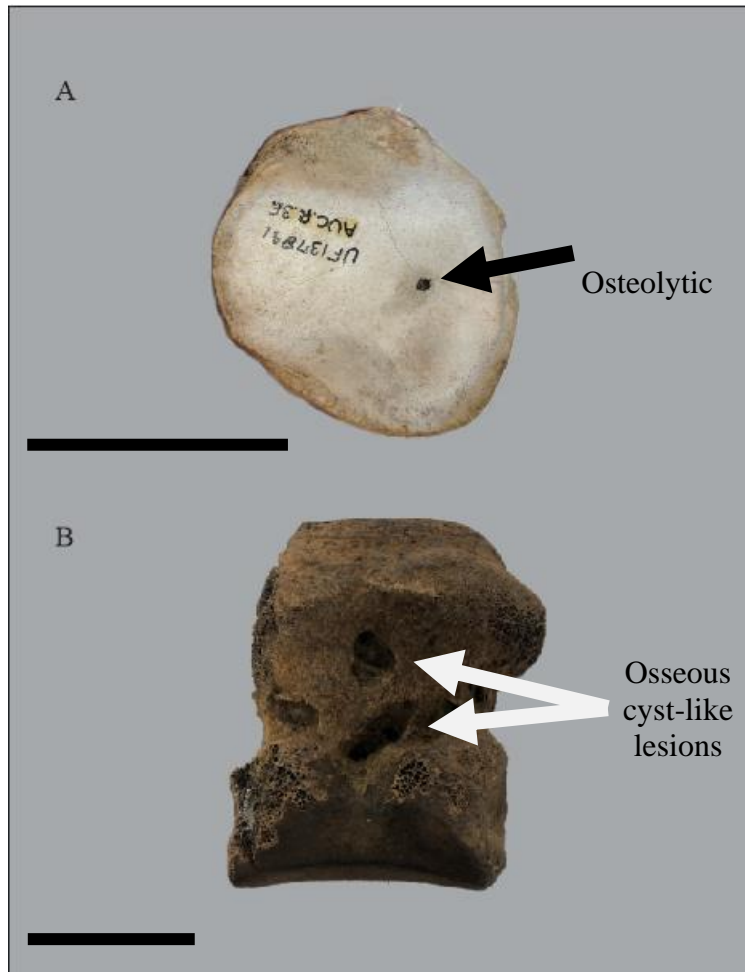


Figure 97: Osteolytic and osseous cyst-like lesion features.
A, Osteolytic feature, present on the trapezium of the UF 137891;
B, Osseous cyst-like lesions on the proximal phalanx III of ETMNH 305. Scale bars A and B = 5 cm respectively.

There are two main types of possible features, both of which are visible in Figure 97 below, on ETMNH 305's manus and these are occasionally present in the other proboscideans: osteolytic features in the articular surfaces and osseous cyst-like lesions on the posterior surfaces. The most abundant pathology overall, present in every single proboscidean in this research, is the osteolytic features. Due to their presence in every individual, these noted "possible pathological features" may not really be pathological. They could be a function of life-history or part of the otherwise normal development of the proboscideans. These features range from approximately 1 to 5 mm. These features are generally circular, with smooth edges, and occasionally the articular surface around the hole becomes depressed, discolored, or on rare occasions, recedes from the hole, forming an indented trail in the articular surface.

The second possible pathological features are osseous cyst-like lesions. These possible pathologies were seen on the posterior side of every ETMNH 305 proximal phalanx except PP1 and were more concentrated on PP3 and PP4. In a study of 21 elephants (52 feet), the osseous lesions represented 15% of all the observed pathologies (Regnault et al. 2017). They are present most commonly on metacarpals (56%) followed by the proximal phalanges (28%) (Regnault et al. 2017). These were only observed in the proximal phalanges of the GFS mastodon. Furthermore, the commonly affected digits were digit IV (27%), digit III (24%), digit II (21%), and digit V (19%) (Regnault et al. 2017). These percentages are similar to the occurrence of these cyst-like lesions in ETMNH 305 as well. The osseous cyst-like lesions were significantly more common in females than males, and typically affected multiple feet with rarely just one foot being afflicted (Regnault et al. 2017). Based on a quick scan of the other manus and pes elements undergoing preparation, the possible pathological features appear to affect both forefeet and hindfeet.

Implications for Mammut

The identification of *Mammut* is often aided by dental and cranial characteristics and although those characteristics are very good at distinguishing between *Mammut* from other proboscideans, there could be potential significant skeletal differences within Mammutids that have not been recognized. Post-cranial characteristics, including those seen in the manus, should be further evaluated to distinguish between different genera. This study cannot adequately distinguish species based on proboscidean manus variations, in part due to the small sample size of the GFS mastodon individuals and those of other proboscidean taxa. Furthermore, morphological differences could be influenced by body size, regional ecomorphology, and/or life history, which could surpass inheritance on skeletal morphology. There were several shape differences between manus elements and their articular surfaces that could be identifying factors between the genera but more specimens are needed to test the variability amongst the proboscideans and especially intra-specific variability. More identifying characters need to be observed on more individuals.

Future Work

As previously stated, this study requires a larger data set, especially since manus elements can vary between individuals of the same species; however, there were obvious differences between the manus elements, especially the carpals and metacarpals, that might not be simple variation between the same species. Because of this, the research should be expanded to include more mani, both rights and lefts, and even pes. Rather than using only linear measurements, 2 and 3 dimensional landmark morphometrics should be added to distinguish between proboscidean genera. The morphometrics would greatly enhance the differences in

shape. Not only should more *Mammut* species be included in a large-scale statistical analysis of phylogeny, but the different species amongst gomphotheres and mammoths should also be included so that dental and cranial characteristics are not so heavily relied on, especially in cases where they are not available. If the differentiation based on fore or hindfoot elements is successful, evolutionary, ontogenetic, and even sexually dimorphic aspects can be applied.

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