

11-30-2015

# Materials Collected by the Southern Branch of the UC Africa Expedition with a Report on Previously Unpublished Plio-Pleistocene Fossil Localities

Tesla A. Monson

*UC Berkeley*, [tesla.monson@wwu.edu](mailto:tesla.monson@wwu.edu)

Marianne F. Brasil

Leslea J. Hlusko

Follow this and additional works at: [https://cedar.wwu.edu/anthropology\\_facpubs](https://cedar.wwu.edu/anthropology_facpubs)

 Part of the [Integrative Biology Commons](#), [Other Ecology and Evolutionary Biology Commons](#), and the [Paleontology Commons](#)

---

## Recommended Citation

Monson, T. A., Brasil, M. F. & Hlusko, L. J. 2015. Materials collected by the southern branch of the UC Africa Expedition with a report on previously unpublished Plio-Pleistocene fossil localities. *PaleoBios*, 32(1). [ucmp\\_paleobios\\_29407](#). *PaleoBios* Official Publication Of the university Of California Museum Of Paleontology *PaleoBios* 32:1-17, December 1, 2015

This Article is brought to you for free and open access by the Anthropology at Western CEDAR. It has been accepted for inclusion in Anthropology Faculty and Staff Publications by an authorized administrator of Western CEDAR. For more information, please contact [westerncedar@wwu.edu](mailto:westerncedar@wwu.edu).

# UC Berkeley

## PaleoBios

### Title

Materials collected by the southern branch of the UC Africa Expedition with a report on previously unpublished Plio-Pleistocene fossil localities

### Permalink

<https://escholarship.org/uc/item/8p91285n>

### Journal

PaleoBios, 32(1)

### ISSN

0031-0298

### Authors

Monson, Tesla A  
Brasil, Marianne F  
Hlusko, Leslea J

### Publication Date

2015-12-01

### Supplemental Material

<https://escholarship.org/uc/item/8p91285n#supplemental>

Peer reviewed

# *PaleoBios*

---

OFFICIAL PUBLICATION OF THE UNIVERSITY OF CALIFORNIA MUSEUM OF PALEONTOLOGY



Tesla A. Monson, Marianne F. Brasil and Leslea J. Hlusko (2015). Materials collected by the southern branch of the UC Africa Expedition with a report on previously unpublished Plio-Pleistocene fossil localities.

**Cover photo:** Mrs. Charles Camp and her son, Charles Camp Jr., in South Africa.

**Citation:** Monson, T. A., Brasil, M. F. & Hlusko, L. J. 2015. Materials collected by the southern branch of the UC Africa Expedition with a report on previously unpublished Plio-Pleistocene fossil localities. *PaleoBios*, 32(1). [ucmp\\_paleobios\\_29407](#).

## Materials collected by the southern branch of the UC Africa Expedition with a report on previously unpublished Plio-Pleistocene fossil localities

TESLA A. MONSON<sup>1,2\*</sup>, MARIANNE F. BRASIL<sup>1-3</sup> and LESLEA J. HLUSKO<sup>1-3</sup>

<sup>1</sup>Department of Integrative Biology,

<sup>2</sup>University of California Museum of Paleontology, and

<sup>3</sup>Human Evolution Research Center

University of California, Berkeley

Berkeley, CA 94720

From 1947 to 1948, paleontologists from the University of California Museum of Paleontology (UCMP), Charles Camp and Frank Peabody, led the southern branch of the University of California's Africa Expedition. While in South Africa, Camp and Peabody collected thousands of specimens excavated from more than 70 sites, 40 of which make up the Plio-Pleistocene South African assemblage at the UCMP. Materials collected by researchers accompanying the expedition are held at numerous repositories on the University of California Berkeley campus including the UCMP, the Museum of Vertebrate Zoology (MVZ), the Phoebe A. Hearst Museum of Anthropology and the University of California's Botanical Gardens.

In 2013, we curated the Plio-Pleistocene paleontological assemblage of the UCMP South Africa collection and cataloged 5,082 specimens from four primary areas: Bolt's Farm, Buxton Limeworks, Gladysvale and Witkrans. Both invertebrates and vertebrates are found in the South African assemblage, with every vertebrate class represented, including mammals, birds, fish, reptiles, and amphibians. We provide a detailed report of the taxonomic diversity of the assemblage and describe three sites that have not yet been reported in the scientific literature: New Cave and Jackal Cave at Bolt's Farm, and Tunnel Wall excavation at Buxton Limeworks. We also offer a historical review of the Africa Expedition and report on the current location of materials collected by members of the southern branch of the expedition and brought to the University of California at Berkeley (UCB) for holding.

**Keywords:** Buxton, Bolt's Farm, Taung, Charles C. Camp, Frank E. Peabody, UCMP

### INTRODUCTION

The University of California Museum of Paleontology (UCMP) in Berkeley, California, organized an expedition to Africa in 1947 with the aim of collecting living and fossil organisms, as well as anthropological and ethnographic data. The expedition consisted of two main branches which concurrently initiated collection in northern and southern Africa. We offer a brief overview of the history of the expedition for both branches but focus our primary discussion on the paleontological material collected by the southern branch.

Charles Camp, chief paleontologist for the UCMP, Frank Peabody, and a host of specialists representing diverse research fields, began surveying for fossil-bearing sites in South Africa in 1947 (Table 1). Camp and his team visited more than 75 fossil sites in South Africa from 1947 to 1948

(Camp 1948). The South African Plio-Pleistocene assemblage of the UCMP represents 40 of those sites (Table 2). The fossil material collected during this expedition was preliminarily prepared in the field and then sent to the UCMP for more exhaustive preparation and curation (Cooke 1990). Original field notes from the expedition are housed in the UCMP archives.

Subsets of this assemblage have been studied since its collection, with the most focus placed on the Old World monkey (OWM) specimens (Freedman 1965, 1976). This particular subset has played a fundamental role in the long and complicated history of OWM taxonomy (Szalay and Delson 1979, Cooke 1990). The majority of the taxonomically diverse collection, however, remains largely unstudied particularly as a comprehensive unit. Here we offer a cursory overview of the expedition and the history of scholarship involving this assemblage, followed by the first comprehensive review of all of the South African sites and the total taxonomic diversity represented in this collection.

\*author for correspondence

**Citation:** Monson, T. A., Brasil, M. F. & Hlusko, L. J. 2015. Materials collected by the southern branch of the UC Africa Expedition with a report on previously unpublished Plio-Pleistocene fossil localities. *PaleoBios*, 32(1). [ucmp\\_paleobios\\_29407](http://ucmp_paleobios_29407).

**Permalink:** <http://escholarship.org/uc/item/8p91285n>

**Copyright:** Items in eScholarship are protected by copyright, with all rights reserved, unless otherwise indicated.

**Table 1.** List of researchers on the southern branch of the UC Africa Expedition.

Researcher	Field of study	Institution	Country
Barbour, Dean George B.	Geology	University of Cincinnati	USA
Bolton, Laura	Ethnomusicology	University of Chicago	USA
Brueckner, Anna Elizabeth (Mrs. Ludlow)	Botany	McGregor Museum Herbarium, University of Kansas	USA
Camp, Charles L.	Paleontology	University of California Museum of Paleontology, University of California Berkeley	USA
Camp, Charles M.	Ethnomusicology	University of California Berkeley	USA
Camp, Mrs. Charles L.			USA
Daranyalaga, Paul	Paleontology	National Museums of Ceylon, India	India
Dart, Raymond	Anthropology	University of the Witwatersrand	South Africa
du Toit, Alexander	Geology		South Africa
Haughton, Sidney H.	Geology	United States Geological Survey	USA
Horst, Cornelius Jan van der	Entomology	University of the Witwatersrand	South Africa
Iflund, Boris	Psychology	University of California Berkeley	USA
Koeh, Carl	Entomology		USA
Larson, Thomas J.	Biology, Anthropology	Museum of Vertebrate Zoology, University of California Berkeley	USA
Loeb, Edwin M.	Ethnology	University of California Berkeley	USA
Loeb, Ella-Marie K.	Art, Photography		USA
Malan, Berry M.	Archaeology	Archaeological Survey of South Africa	South Africa
Peabody, Frank	Paleontology	University of California Museum of Paleontology, University of California Berkeley	USA
Rodin, Robert J.	Botany	Herbarium, University of California Berkeley	USA
Tomlin, John R. le B.	Malacology	Malacological Society of London	England
Tracey, Hugh	Ethnomusicology	African Musical Research Institute	USA
van Riet Lowe, Clarence	Archaeology	University of the Witwatersrand	South Africa
Wells, Lawrence H.	Physical Anthropology	University of the Witwatersrand	South Africa
Williams, Eric W.	Physical Anthropology	University of the Witwatersrand	South Africa

### History of scholarship on the collection

A preliminary list of the collection contents, including archaeological material, was compiled and published as part of an overview of the geology of the collection area during the curation and preparation of the fossil material at the UCMP (Peabody 1954). In 1961, the South African collections from the Buxton quarry were loaned to Leonard Freedman at University of the Witwatersrand where they were reviewed in great detail and with particular focus on illustration and taxonomic description of the primate material (Freedman 1965). At the time of the loan to Freedman, several specimens in a block of breccia (UCMP 56831) had

not yet been prepared and were not included in the initial 1965 publication. Much of the primate material was further prepared and studied by Eric Delson at the American Museum of Natural History between 1968 and 2007. Many of these UCMP OWM specimens have been taxonomically reassigned following their initial description (Szalay and Delson 1979, Gilbert 2007a).

The micromammal specimens were identified preliminarily by then University of California, Berkeley (UCB) graduate student Charlotte Holton. In 1958, a small sample of this material was sent to Jurgens Meester and David Davis in South Africa for further identification. Apart from

examination by Percy Butler of Royal Holloway College in 1974, the specimens remain unstudied following their return to UCB (Cooke 1990).

Following Peabody (1954), Cooke (1990) offered the first review of the UCMP South African collection from the Buxton Limeworks and a brief history of study for each of the faunal constituents. Cooke (1990) described subsets of the faunal collection, including quantitative and qualitative specimen descriptions, and made preliminary identifications where possible for mammalian taxa. He also noted the presence of reptile and bird taxa in the collection, describing two particularly well-preserved specimens: a turtle shell and an owl cranium. A small subset of the carnivoran material has also been described in addition to Cooke's (1990) contribution (Gingerich 1974, Cooke 1991), although a comprehensive review of all carnivoran material remains to be completed.

### Returned material

Following the loan of the OWM specimens to Freedman in 1961, the collection was returned to Ruben Stirton at UCB in 1962 with the exception of a small subset retained at University of the Witwatersrand (UW). This subset includes cranial type specimens (including both holotypes and allotypes), of which casts were sent to UCB. The cranial specimens maintained at UW include: UCMP 56604 (also TP 9), 56605 (also TP 10), 56606, 56608, 56652, 56765, 56784, and 56785 (Tobias 1968). The majority of the postcranial material (n=36) was also returned to UW, including: UCMP 56710-56739, 56761, 56763, and 56764 (Tobias 1968).

### The UC Africa Expedition

The UC Africa Expedition was popularly described as the largest scientific operation of its kind, involving equipment worth over half a million dollars at the time, several naval tankers, and dozens of international researchers (Nicol 1947). The expedition was supported by the Egyptian Government, the Geological Society of America, the American Philosophical Society and the National Academy of Sciences, South African Premier Marshall Jan Smuts, and several high-ranking United States military officers (Anon. 1947a, Camp 1948). The materials collected on this massive expedition continue to have a profound influence on scientific research across a range of disciplines (e.g. Hudson 2000). There were two branches of the expedition; one in the north and one in the south.

*The northern branch*—The northern branch of the expedition, led by field director Wendell Phillips of the UCMP, set up its operations base in Cairo, Egypt in 1947 (Anon. 1947d). Phillips, only 25 years old at the time of the expedition, was

assigned the command after securing more than \$500,000 in funds for the trip (approximately \$5.3 million in year 2015 with inflation calculated). Noted for his persuasive attitude, Phillips acquired donations from various sources: guns from Colt, 10 sedans from Chevy, and more than 50,000 gallons of oil from General Motors, as well as the support of renowned paleontologists Charles Camp (UCMP) and Louis S.B. Leakey (British Museum and National Museums of Kenya) (Sobocinski 2013). The goals of the northern branch, as they were originally stated, were to find additional specimens of the Oligocene Fayum ape *Propliopithecus* Schlosser, 1910 (Anon. 1947d).

The northern expedition was operated jointly with the US Navy, officially commencing in Port Said, Egypt in February of 1948 (Sobocinski 2013). They traveled south over land by the Sudan Road, and from April to August members of the expedition operated from a base in Nairobi collecting specimens and data throughout central Africa, from Kenya to the eastern Belgian Congo (present-day Democratic Republic of the Congo; Sobocinski 2013). The Navy team, represented on the expedition by Commander Julius Amberson, included parasitologists, zoologists, and other medical technicians interested primarily in medical intelligence (Amberson 1978). Amberson, a tropical disease specialist, led his team in collecting blood samples and information about tropical diseases, and in distributing medical supplies to locals (Sobocinski 2013).

There was some disagreement between the Navy team and the northern branch regarding the direction of the expedition as led by Phillips. Amberson disassociated from Phillips in June of 1948, writing to his supervisor Admiral Pugh that Phillips' nefarious actions on the expedition were an embarrassment to locals and the Navy alike (Sobocinski 2013). Phillips' documented interest in the archaeology of the Queen of Sheba and Jesus Christ (Anon. 1969, Pillalamarri 2014) may have been a factor in his disassociation from Amberson. The northern branch of the expedition continued on without the Navy team, meeting up with the southern branch in Cape Town, South Africa on October 19, 1948, after traveling more than 19,000 miles by jeep caravan across the African continent (Sobocinski 2013). Following the expedition, Wendell Phillips continued his explorations of the Arabian desert, eventually amassing over \$120 million in oil leases, more than 20 US honorary doctorates, and the honored title of Bedouin sheikh (Pillalamarri 2014).

*The southern branch*—Inspired by recent discoveries of *Australopithecus* Dart, 1925 fossils, the southern branch of the UC Africa Expedition set out in August of 1947 in the hopes of finding additional specimens of the Plio-Pleistocene hominid (Broom 1936, Anon. 1947e, Camp 1948). Led by

**Table 2.** Localities represented in the UCMP South African Plio-Pleistocene assemblage. **MSA** = Middle Stone Age, **LSA** = Later Stone Age.

Numbered Location, Fig. 1	UCMP Locality	FEP	Pit #	Site Name	Alternate Names	Geologic Age	First Report	Number of Specimens in UCMP	Additional Literature
1	V67256	55-1	1	Kraal Pit	U.W. 34	1-2mya?	Cooke 1991	2	Gingerich 1974; Thackeray et al. 2008
1	V75133	55-1 (LF)	1	Kraal Pit, loose fill				57	
2	V67257	55-2	2	Kiln Pit	U.W. 35, H Cave	1-2mya?	Cooke 1991	142	
3	V67258	55-3	3	Cobra 1	U.W. 36, Kaffir Beer Cave	1-2mya?	Cooke 1991	750	Cooke 1993; Reynolds 2007; Gommery et al. 2012
3	V75132	55-3b	3	Cobra 2	Kaffir Beer Cave 2	1-2mya?	Cooke 1991	244	Cooke 1991; Gommery et al. 2012
4	V67259	55-4	4	Garage Ravine	U.W. 37		Cooke 1991	5	Badenhorst et al. 2011; Gommery et al. 2012
5	V67260	55-5	5	Smithy	U.W. 38, Smith Cave		Cooke 1991	1	Gommery et al. 2012
5	V75139	55-5 loose	5	Smithy, loose				1	Gommery et al. 2012
6	V67261	55-6	6	Baboon	U.W. 39	1-2mya	Cooke 1991	67	Freedman 1965; Cooke 1991; Gommery et al. 2012
7	V67262	55-7N	7	Elephant	U.W. 40, Bridge Cave	1-2mya	Cooke 1991	196	Cooke 1993; Gommery et al. 2010, 2012
8	V75269	55-8	8	Rodent	U.W. 41		Cooke 1991	2	Gommery et al. 2012
9	V67263	55-10	10	Grey Bird Pit	U.W. 43, Main Quarry	1-1.5mya	Cooke 1991	216	Gilbert 2007b
10	V67264	55-14	14	Bench Mark Pit	U.W. 48		Cooke 1991	116	Cooke 1993; Gommery et al. 2012
11	V73105	55-15	15	Aves Pit	U.W. 49		Cooke 1991	1	Gommery et al. 2012
12	V67265	55-16	16	Equine Pit	NOT Equus Cave	MSA/LSA	Peabody 1954	129	Cooke 1991
13	V4888	55-23	23	Tit Hill Pit	U.W. 50, V67288, Femur Dump	2mya	Peabody 1954	160	Freedman 1965; Cooke 1991; Gommery et al. 2008, 2012
13	V67270	55-23-dump	23	Bolt Farm Dump	55-sinkhole		Cooke 1991	69	Gilbert 2007b, 2013; Gommery et al. 2008, 2012
14	V67267	55-25	25	Gazelle Pit			Cooke 1991	8	Cooke 1991
15	V67268	55-New Cave	New	New				19	
16	V67269	55-JC		Jackal				1	
17	V67271	38-1	Middle Quarry 2	Middle Quarry 2	U.W. 5, Lower Breccia, Lucky Moon Cave Complex, Middle Face of Quarry 2	oldest surface breccia/MSA	Malan 1950	14	Peabody 1954; Partridge 1985; McKee 1993a, b, 1994
18	V67276	38-5	Australopithecus	Australopithecus	Taung Type Site, Dart's Cave - Site 9	2-3mya	Dart 1925	202	Freedman 1970; Gilbert 2007a, 2013



**Table 2** (continued). Localities represented in the UCMP South African Plio-Pleistocene assemblage. **MSA** = Middle Stone Age, **LSA** = Later Stone Age.

Numbered Location, Locality Fig. 1	UCMP Locality	FEP	Pit #	Site Name	Alternate Names	Geologic Age	First Report	Number of Specimens in UCMP	Additional Literature
19	V4738	38-5a		Lower Australo-pithecus	5/51 - Hrdlika's Cave (Broom), Taung	2-3mya	Peabody 1954	176	Freedman 1970
20	V67275	38-5b		Upper Australo-pithecus	5/2 - Hrdlika's Cave, Taung Limestone Site 5	2-3mya	Peabody 1954	128	Gilbert 2007a, 2013
20	V67277	38-5 dump		Buxton Dump	5c	MSA/LSA	Peabody 1954	4	Cooke 1990
21	V67278	38-8		Tunnel Wall		MSA/LSA		1	
22	V7039	38-12		Blue Pool	Blue Pool Cave Shelter	LSA	Peabody 1954	2	Davis 1959; McKee 1994
23	V67279	38-14		Black Earth 1	Gallery A	MSA/LSA	Peabody 1954	88	Humphreys 1978; McKee 1994
24	V67280	38-17		Black Earth 2	U.W. 63, 38-18A; Gallery B	MSA/LSA	Peabody 1954	127	Humphreys 1978; McKee 1994
25	V67281	38-18		Black Earth 3	U.W. 63, 38-18B; Gallery C	MSA/LSA	Peabody 1954	554	Gingerich 1974; Humphreys 1978; McKee 1994
26	V67282	38-19		Ochre		LSA	Peabody 1954	104	
27	V67283	38-27		Powerhouse		LSA	Peabody 1954	2	Humphreys 1978; Klein 1979; Hall et al. 1980; McKee 1993; Wadley 2000
28	V67284	38-28		Peabody	U.W. 58	LSA/comparable to Equus	Cooke 1990	66	McKee 1994
29	V6853	38-29		East Pit	U.W. 68, Satan Cave	MSA/LSA		1	McKee 1994
	V4740	40		Witkrans	Little Witkrans	LSA	Peabody 1954	1	Klein 1979; Humphreys and Thackeray 1983; Parkinson and Hall 1987; Ernst 1989; Klein et al. 1991; McCrossin 1992; McKee 1993; Forssman et al. 2010
	V4741	41		Iskor Lime			Peabody 1954	9	
	V4742	42		Boetsap	Fossil Hill, Lion Head	1-2mya	Peabody 1954	15	
	V4743	43		Witkrans 2		MSA/LSA	Young 1925	579	Peabody 1954
	V67285	43-loose		Witkrans Pot-hole	Witkrans 2, loose	MSA/LSA		62	Malan 1950
	V4885	52		Gladysvale	U.W. 3, SAAN-001, Uitkomst Cave, John Nash Cave, loc. 91 (Acc. 988, Hearst)	1.6-2mya	Broom & Schepers 1946	761	Brain 1981; Martini and Keyser 1989; Berger and Brink 2000
								<b>Total</b>	<b>5082</b>



the director of the UCMP, Charles Camp, and with assistance from Frank Peabody, also of the UCMP, the southern branch of the expedition united dozens of Berkeley and South African researchers in a massive paleontological and anthropological survey of southern Africa (Anon. 1947a; Larson 2004). Each scientist had unique research aims, and a remarkable array of materials was collected (Camp 1948). For fifteen months between 1947 and 1948, the southern branch surveyed across South Africa, South-West Africa (present-day Namibia), Northern Rhodesia (present-day Zambia), Southern Rhodesia (present-day Zimbabwe), and Angola, sampling a broad variety of fossil, extant and ethnographic specimens (Camp 1948). Although the Plio-Pleistocene Buxton Limeworks and Bolt's Farm collections have received the most attention, the material from other sites ranges from the Permian to present, from extinct amphibians to native music. At least seven UCB campus repositories maintain holdings from the southern branch of the UC Africa Expedition.

#### Additional material

*Paleozoic and Mesozoic fossil material*—Along the first segment of the southern branch of the expedition, Camp and Peabody excavated a series of Cretaceous deposits in South Africa (Camp 1948). Several fossil cynodonts were excavated near Rouxville (Free State province), and multiple species of reptiles and amphibians were excavated from Harrismith (Free State province; Anon. 1948). Later in the expedition, Camp and Peabody spent six weeks in the Karoo Desert of South Africa excavating dozens of therapsids. Additionally, more than 95 reptiles and amphibians (e.g., UCMP 39388, 40499, 42007, 41286) were collected at the Triassic site Thaban'chu in the Free State province of South Africa. Several of these specimens have been referenced in publication (e.g., Welles and Cosgriff 1965, Morales and Shishkin 2002, Damiani 2008). While in South-West Africa (Namibia), Camp also excavated early Permian materials including *Chondrichthyes* Huxley, 1880, *Osteichthyes* Huxley, 1880 and reptiles (e.g., UCMP 71479, 71480, 71481, 115325, 115326, 115338).

*Extant vertebrate and invertebrate material*—Many extant vertebrates, both live and dead specimens, were collected by the expedition and are now held at various institutions. Thomas Larson, mammalogist of the University of California Museum of Vertebrate Zoology (MVZ), collected hundreds of vertebrate specimens, including elephant shrews and golden moles (Ray 1947), and antelope skulls from lion kills in Kruger Park (Ray 1948). More than 1,200 vertebrate specimens, ranging from *Xenopus* Wagler, 1827 (e.g., MVZ 64933) to *Nycteris* Cuvier and Saint-Hilaire, 1795 (e.g., MVZ 117099) were collected by Larson in South Africa, South-West Africa

(Namibia), and Northern Rhodesia (Zambia) and are currently stored at the MVZ.

The northern branch of the expedition also collected vertebrate material, primarily for medical purposes (Sobocinski 2013). William Terry collected a shipment of elephant shrews with the help of local children in South Sudan (Sobocinski 2013). Four animals were shipped to the Institute of Tropical Medicine at UCSF to be studied by Herbert Johnstone, and more than one hundred animals went to the Naval Medical Research Institute in Bethesda (Turner 1948). Terry, a former Army Air Force Corps technical officer, made national news with his plans to use cutting-edge x-ray and radium photography methods to search for fossils in South Africa (Anon. 1947b).

As a smaller focus of the expedition, several invertebrate specimens were collected and identified by expedition researchers. A new genus of extant mollusk (*Afrivoluta pringlei* Tomlin, 1947, UCMP 164288), endemic to South Africa, was collected by the expedition and described by famed British malacologist John Tomlin (1947). The expedition entomologist, Carl Koch, accessioned a new species of extant *Volutocorbis* (*V. lutosa* Koch, 1948) that he trawled in Cape Province (in the present-day Western Cape province; UCMP 165855). Also stored in the UCMP are recent specimens of *Tenagodus wilmanae* Tomlin, 1918 (UCMP 171160) and *Megatebennus africana* Tomlin, 1926 (UCMP 168755), both identified by Tomlin. Invertebrate specimens collected by the expedition are also stored at the California Academy of Sciences in San Francisco, CA.

*Botanical material*—Robert Rodin, graduate student at UCB and botanist of the expedition, collected more than 30,000 plants and seeds between Cape Province and the Namib Desert (Ray 1947, Camp 1948). Many of the live specimens collected persist in the UC Botanical Gardens, comprising a large section of the native African plants and succulent collections (Hogan 1990). One of the rare plants collected by Rodin is *Welwitschia* Hooker, 1863, a southern African endemic that lives for more than 1,000 years (Camp 1948, Rodin 1953). A specimen of *Welwitschia*, propagated from seeds collected by Rodin during the expedition (Rodin 1948) is currently maintained in the succulent house at the UC Botanical Gardens. Rodin also collected for other herbaria in the United States and South Africa, and thousands of specimens, ranging from succulents and flowering plants to marine algae and seaweeds, were deposited in the UCB Herbarium (e.g., *Caulacanthus ustulatus* Kützing, 1843, Herbarium specimens UC1474618, UC1474606; Rodin 1948). Several reports mention the collection of fossil plant material at the Taung site within the Buxton Limeworks (e.g., Peabody 1954, Butzer 1974). The current location and taxonomic

affinity of these fossils remains unclear, although Rodin's letter to Lincoln Constance in 1947 confirms the existence of the original collection (Rodin 1947).

As part of the expedition, Rodin also spent considerable time in Kaokoveld, the petrified forest of Namibia (Rodin 1951). Kaokoveld was discovered in the Doros Crater of the Kaokoveld Desert by Camp during the expedition and is comprised almost entirely of petrified *Dadoxylon arberi* Seward, 1917 trees dated to the Permian (Rodin 1951). The forest is the largest of its kind in Namibia, and it was declared a National Monument in 1950 (Vogt 2004).

Rodin also collected data on the ethnobotanical practices of several South African tribes (Anon. 1947c). Focusing on edible and medicinal plants, Rodin recorded numerous observations on plant abundance and usage (Rodin 1948). Rodin (1985) later combined his work from the 1947 expedition with research conducted in the 1970's to publish a monograph with the Missouri Botanical Garden on the ethnobotany of the Kwanyama Ovambos.

*Photographic material*—Several researchers on the expedition were interested in the culture and biology of living humans of southern Africa, and collections of ethnographic and archaeological materials are stored at various UCB museums and archives. Most of the photos and related archival materials can be found at the UC Archives and the Bancroft Picture Library. The Charles Lewis Camp collection (call number BANC PIC 1973.068) contains photographs related to the expedition including photographs of the paleontological expeditions and fossil specimens collected, and photos of living African wildlife and native people.

The Ovambos, a group in South Africa, were a subject of interest for many members of the expedition. In addition to the botanical observations made by Rodin, Edwin Loeb collected ethnographic information on the Ovambos, and Boris Iflund accompanied Loeb to conduct a series of psychological tests (Ray 1948, Camp 1948). On a second trip, the Loeb-Iflund branch of the southern expedition was joined by two physical anthropologists from Raymond Dart's lab at University of the Witwatersrand, Eric Williams and Lawrence Wells, as well as entomologist Carl Koch (Ray 1948, Camp 1948). More than 350 photographs documenting the daily life of the Kuanyama and Ovambo, credited to Iflund, Rodin, Shertz and Mrs. Loeb, are stored in the UC Archives (call number UARC Album 26).

*Musical material*—Several sets of sound recordings from the expedition are held at the UC Music Library. Five compact discs, reissued from the original reel-to-reel tapes, contain material recorded by Hugh Tracy and Charles Camp in Northern Rhodesia (Zambia), Southern Rhodesia (Zimbabwe), and South Africa, including recordings from Zululand

and Johannesburg (call number MUSI CD19359). Famed ethnomusicologist Laura Boulton also made recordings on the expedition. Seven tape reel recordings featuring selections recorded in South-West Africa (Namibia), Angola and South Africa were copied from the master discs held at the University of California, Los Angeles and are now stored at the UC Music Library, Berkeley (call number MUSI TS19).

*Anthropological material*—The Phoebe A. Hearst Museum of Anthropology (PAHMA) received the majority of the archaeological materials from the expedition through the UCMP, all deposited into the museum between 1949 and 1952 (Pellegatti 2014). Many of these artifacts were collected by the southern branch of the expedition, but a large series of stone artifacts and petroglyphs collected by the northern branch from El Koneisa, Egypt are also currently stored at PAHMA (Pellegatti 2013).

The southern branch of the expedition collected archaeological materials spanning the Late Pleistocene and Holocene. Many of the younger sites at Buxton Limeworks and Bolt's Farm are dated by the presence of Middle Stone Age (MSA) and Late Stone Age (LSA) artifacts (Camp 1948, Peabody 1954, Humphreys 1978, McKee 1994), and dozens of stone cores, flakes, endscrapers and other lithics were accessioned into the PAHMA. Decorated eggshells, beads, and bone tools are also among the plentiful archaeological materials (Anthropology Accn. 988).

The anthropologists also collected materials from living human populations. A series of correspondences between Alexander du Toit and then-PAHMA director William Bascom indicate that several figurines collected on the expedition were definitively identified as belonging to the Kwangari Ovambo in 1967 (Anthropology Accn. 988). Other artifacts listed in the accession notes include carved idols, stools, and shields, all attributed to the Kwangari Ovambo (Anthropology Accn. 988).

## MATERIALS AND METHODS

We now turn our focus to the paleontological collections from this expedition. This fossil assemblage includes a total of 3,284 taxonomically identified specimens, and 1,798 unidentified specimens. When possible, specimens were identified to Class. Within Class Mammalia, specimens were identified to Order if enough morphology was preserved to do so. Taxonomic identifications were aided by the examination of comparable extant specimens in the MVZ. In the absence of comparable material, identifications were made based on comparisons with published illustrations and descriptions. Apparent discrepancies in sample sizes reported in Table SM1 and the following locality descriptions are due to different numbers of specimens that are physically present in the



UCMP, specimens that have been taxonomically identified, and specimens cataloged online. For a complete count of all specimens present in the UCMP, reference Table 2. A count of all specimens identified to mammalian order, to other classes of vertebrate, or as invertebrates, is tabulated in Table 3. For several of the sites, the online UCMP catalog does not yet represent the complete South African assemblage.

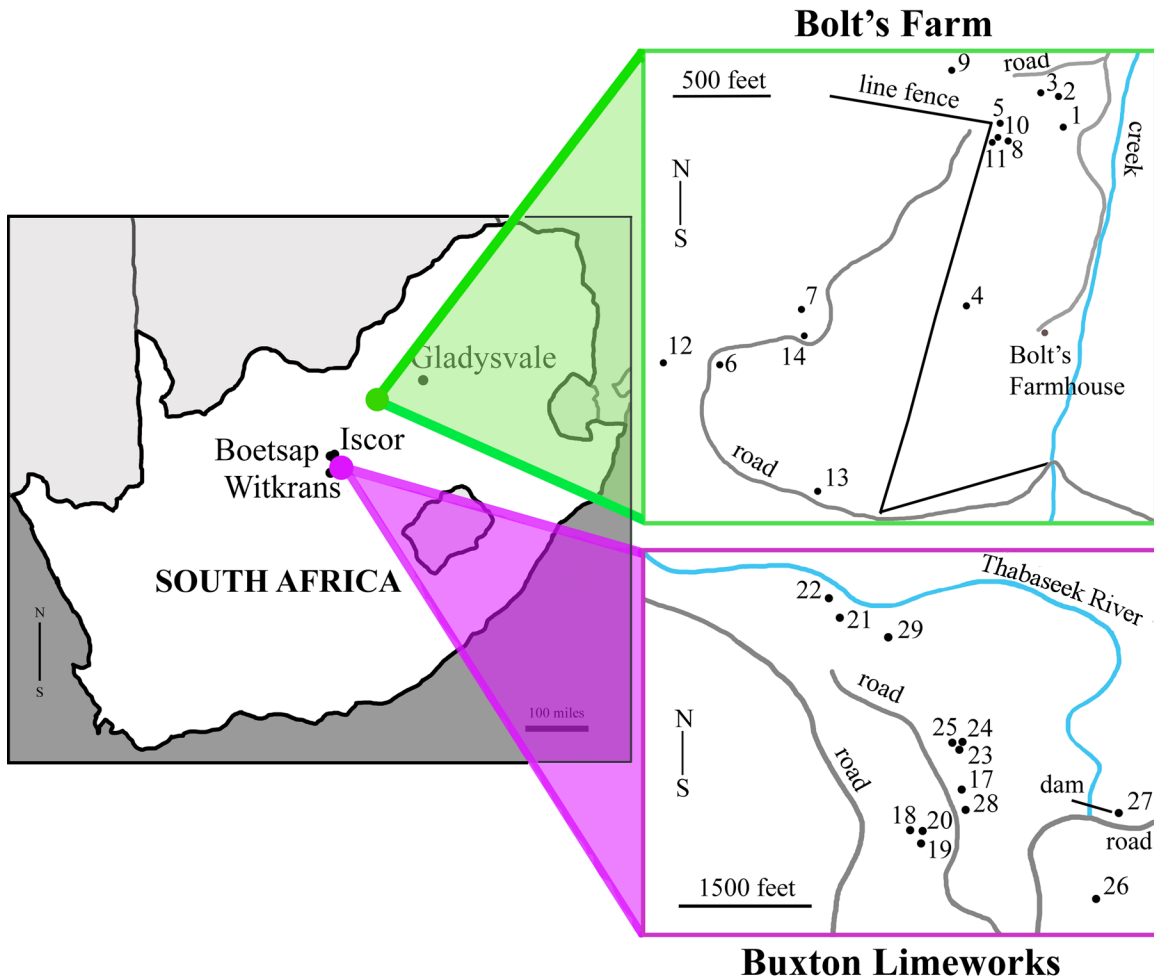
RESULTS

Fossil localities

There are 40 South African localities represented in the assemblage at the UCMP (Table 2). These localities fall under four primary areas: Bolt’s Farm, Buxton Limeworks, Gladysvale, and Witkrans (Fig. 1). Each area is briefly described below, with particular attention paid to three previously unpublished sites.

*Bolt’s Farm*—Frank Peabody surveyed the Bolt’s Farm area, Gauteng Province, South Africa, assigning numbers (i.e., FEP numbers) to each locality (Fig. 1, SM1, Table 2). The area includes a small hill above a seasonal creek, and is comprised primarily of limestone and chert (Peabody 1954). Most of the localities visited by Peabody have since been destroyed by mining operations, although excavations continue at some of the old pits (Thackeray et al. 2008), and new pits have since been opened (Gommery et al. 2012). Since Bolt’s Farm specimens are labeled by locality name in the UCMP, localities are referred to here by name with the corresponding Pit numbers assigned by Peabody following in parentheses. It is important to note that the correspondence between locality names used by us at Bolt’s Farm and those originally assigned by Peabody is not entirely resolved. Therefore, it is possible that the names we use to refer to the deposits at Bolt’s Farm differ from the names assigned by

**Figure 1.** Map of South African Plio-Pleistocene localities represented in the UCMP. Pits are mapped from Peabody’s original field maps (see downloadable supporting material). The exact locations of New Cave (location no. 15, Bolt’s Farm) and Jackal Cave (numbered location 16, Bolt’s Farm) are unknown. Although Cooke (1991) reported an alternate location for Gazelle Pit (numbered location 14, Pit 25, Bolt’s Farm), here this pit has been placed according to Peabody’s original field maps.







**Figure 2.** A–G. UCMP specimens from New Cave (UCMP V67268). The specimens have been relabeled to reflect their association with New Cave (UCMP V67268) as determined by FEP numbers. What appears to be FEP 56 is actually FEP 55. **A.** Left proximal radius (Class: Mammalia) **B.** Proximal end of rib (Class: Mammalia) **C.** Premolar and molar teeth (Family: Bovidae) **D.** Right astragalus (Family: Bovidae) **E.** Proximal phalanx (Family: Bovidae) **F.** Coprolite (Class: Mammalia) **G.** Distal phalanges (Family: Bovidae)

Peabody but the limited provenience information available precludes the possibility of determining whether this is the case. During the accessioning process of the UCMP, several pits have been divided into two locality numbers and given separate names. For example, Cobra Cave 1 (Pit 3; UCMP V67258) and Cobra Cave 2 (Pit 3; UCMP V75132) represent two distinct localities in the UCMP collections, but originate from a single pit excavation. Corresponding UCMP locality numbers, pit numbers and cave names can be tracked in Table 2.

Bolt's Farm localities vary widely in geological age, with

exact age varying across individual pits (Sénégas and Avery 1998, Gommery et al. 2014). Kraal Pit (Pit 1) is dated at approximately 1 Ma to just under 2 Ma on the basis of faunal correlations with Olduvai Lower Bed II and Bed I (Gingerich 1974). The bovid composition of the material collected from Cobra Cave 1 (Pit 3) suggests an age of 1 to 1.5 Ma (Reynolds 2007). Baboon Cave (Pit 6) and Grey Bird Pit (Pit 10) have not been specifically dated, although other cercopithecoid-bearing deposits at Bolt's Farm have been estimated at 1.5 to 2 Ma (Delson 1984, 1988, Cooke 1991). Tit Hill Pit (Pit 23) is dated at just older than 2 Ma based on cercopithecoid

composition (Delson 1984). Bolt's Farm Dump (Pit 23 Dump) is estimated at 1.5 to 2 Ma, following from the age assigned to Tit Hill Pit (Pit 23) (Gommery et al. 2008). It was first suggested by Cooke (1991), and more recently supported by Gommery et al. (2008), that the Bolt Farm Dump locality (also Pit 23 Dump) was likely a death trap in which faunal remains accumulated over time. This suggestion is supported by the faunal composition of this site, which includes mostly primate and felid remains (Brain 1981).

Most of the Bolt's Farm localities represented in the UCMP collection have been previously described and are therefore excluded from individual description here (see Table 2 for first report references; see Thackeray et al. 2008 for a review of work at Bolt's Farm). Two newly described Bolt's Farm sites are included here: New Cave (FEP 55-New, UCMP V67268) and Jackal Cave (FEP 55-JC, UCMP V67269).

New Cave (FEP 55-New, UCMP V67268) is a site at Bolt's Farm. The exact location of the site is unknown and is not recorded in the expedition field notes. A total of 13 specimens from this site locality are stored in the UCMP (Fig. 2), although only two (UCMP 89565, 89566) have been added to the online catalog. The assemblage excavated from New Cave is comprised of extant bovids (Family: Bovidae) and a single equid tooth (Family: Equidae), suggesting a Late Pleistocene to Holocene date for the site (Vrba 1979, Eisenmann 1992). Specimen 89565 is a collection of bovid teeth ( $n=7$ ) identified as *Damaliscus pygargus* Pallas, 1767. Specimen 89566 is a lower left second molar identified to *Alcelaphus* Pallas, 1766. Two pedal bones, a right phalanx and a right astragalus are identified only to Bovidae. There is also one upper left third premolar identified as *Equus burchelli* Boddaert, 1785 (Equidae), an extant species of common zebra (Gray 1824). Six mammalian bone fragments including a rib fragment, the proximal end of a left radius, a partial mandible, two isolated teeth and a fossil coprolite have yet to be identified beyond class.

Jackal Cave (FEP 55-JC; UCMP V67269) is a site at Bolt's Farm from which only a single specimen (UCMP 89567) is housed at the UCMP. Specimen 89567 is the incomplete skull of *Canis mesomelas* Schreber, 1775 (Family: Canidae) in breccia (Fig. 3). The black-backed jackal, still present in South Africa today, has a rich Pleistocene fossil record and is considered one of the most basal members of the canids (e.g., Ewer 1956, Klein et al. 1991, Walton and Joly 2003).

**Buxton Limeworks**—The sites in the Buxton Limeworks area are all travertine caves formed in the Kaap escarpment, the eastern rim of a large plateau commonly known as Campbell Rand (Peabody 1954). The Buxton Limeworks are composed of a series of successive travertine deposits including Thabaseek, Norlim, Oxland, and Blue Pool

(Peabody 1954; Figs. SM2, SM3, SM4, SM7). The economic value of limestone has motivated extensive travertine mining operations throughout the Buxton Limeworks area. Many of the fossiliferous sites mentioned here are now protected by recognition of Buxton Limeworks as an UNESCO World Heritage site in 2005 (World Heritage Committee 2005).

Early reports estimated geological age for the Buxton area to be approximately 1 Ma (Partridge 1973, Vogel and Partridge 1983), but these estimates have been reevaluated more recently (Delson 1984). Current estimates date the Buxton Limeworks area at approximately 2.3 Ma on the basis of a questionable application of cercopithecoid biochronology (Delson 1984, 1988), 2.4 to 2.6 Ma based on broader faunal analysis (McKee 1993), and 2.6 to 3 Ma as the result of a multidisciplinary approach incorporating radiometric ages, paleomagnetic records, and biochronology (Herries et al. 2013). Considering these three recent estimates in combination, the age of the Buxton material corresponds approximately to the Pliocene-Pleistocene boundary at 2.58 Ma (Gibbard et al. 2010).

Most of the Buxton Limeworks localities represented in this collection have been described extensively in the literature, and are therefore not described individually here (see Table 2 for locality references). However, one Buxton Limeworks site is described here for the first time: Tunnel Wall (FEP 38-8; UCMP V67278).

Tunnel Wall is a small excavation in the wall of a tunnel 40 feet north of the entrance to the Oxland Travertine. The site is associated with Tunnel Mouth Bank (UCMP V67274), and New Tunnel Ditch (UCMP V67273), although no specimens for either of these associated localities are stored in the UCMP. Overlapping locality information on some specimens suggests that other sites (FEP 38-4, 38-7b), including Equus Cave (FEP 38-7a), may also be associated with Tunnel Wall, although the nature of this association remains unclear as a result of limited curatorial records. Tunnel Wall and associated caves are all dated to the MSA and LSA by the presence of stone tools (Anthropology Accn. 988). Only one Tunnel Wall specimen (UCMP 89754), including several ostrich eggshell fragments (Struthio Linnaeus, 1758), could be located in the UCMP (Fig. 4). Other specimens excavated from Tunnel Wall but not held at the UCMP include equid, bovid and microfelid fragments (Anthropology Accn. 988).

**Gladysvale**—Gladysvale is a well-documented dolomitic cave occurring in the Eccles formation, located in the John Nash Reserve area (Broom and Schepers 1946). Continued excavations have assigned additional names to this site, including Uitkomst Cave (Brain 1981) and John Nash Cave (Martini and Keyser 1989). The geologic age of Gladysvale is estimated at 1.7 to 2.5 Ma on the basis of macromammal





**Figure 3.** UCMP specimen from Jackal Cave (V67269). *Canis mesomelas* partial cranium in breccia, with the palate in oblique ventral view, UCMP 89567. The rostrum extends upwards toward the middle of the block, and the left maxillary dentition is visible to the right. The breccia block also contains several micro-mammalian bone fragments.

composition (Berger 1993, Berger et al. 1993). The UCMP houses 761 specimens from this locality, the majority of the sample consisting of artiodactyls, rodents, soricomorphs, perissodactyls, and chiropterans (Table 3).

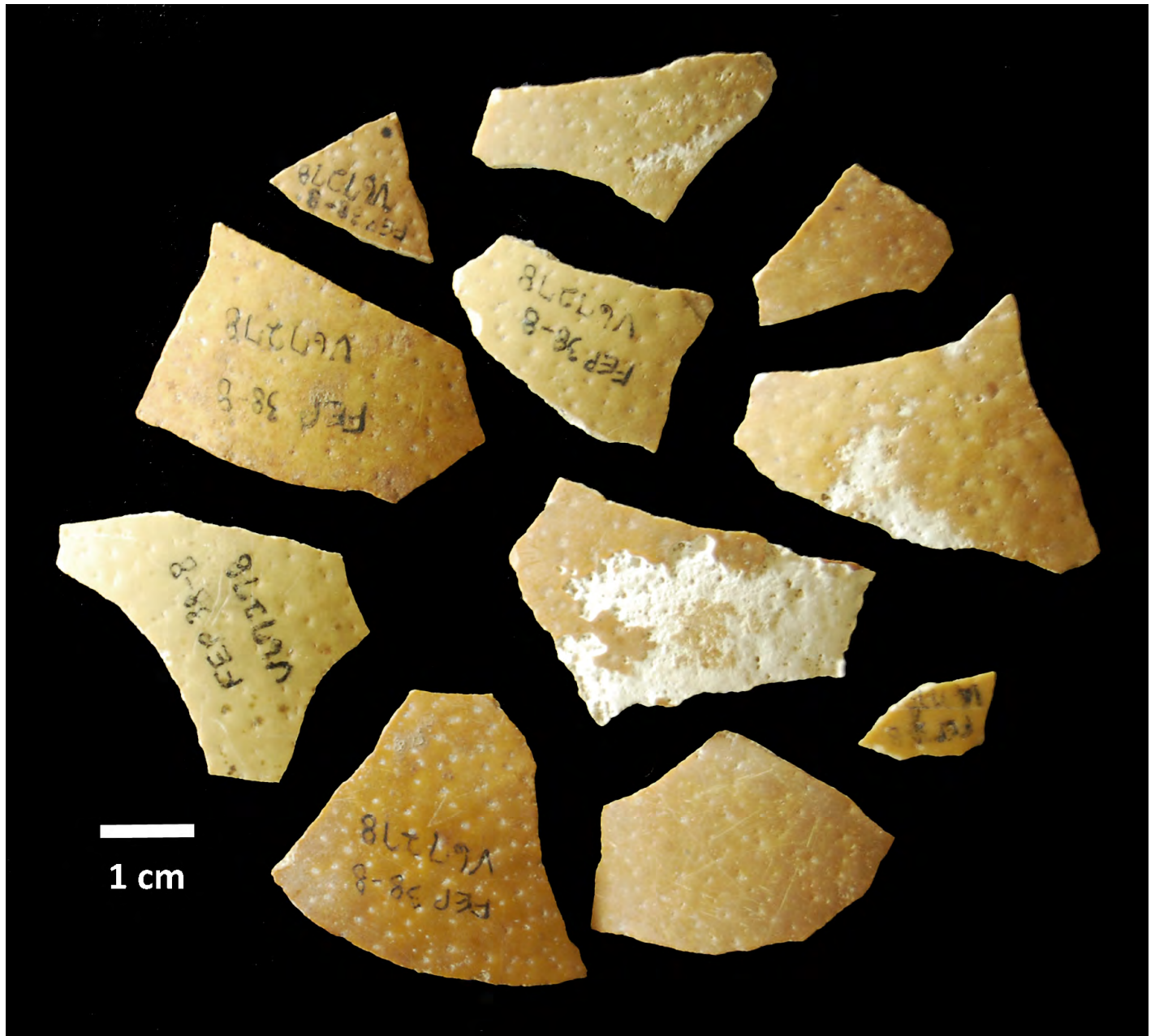
*Witkrans*—Witkrans is a cave formed in a mass of travertines built out from a cliff of dolomite that forms the escarpment (Peabody 1954; Figs. SM5, SM6). Despite the moniker, Witkrans 2 (FEP 43, UCMP V4743) is the primary cave at Witkrans, located approximately 750 meters northwest of Witkrans and four and half kilometers southeast of the Norlim post office. The site is a deposit in an unroofed cave carved out in lime built out from the escarpment (Peabody 1954). Peabody excavated stone tools from the MSA and LSA of the Wilton Industry and suggested that the deposition of bone

and artifacts reflects some level of continuous occupation by modern humans (Peabody 1954). A total of 579 specimens from this locality are housed in the UCMP, although only 76 are cataloged. The majority of the assemblage from this locality consists of artiodactyls and unidentified mammals (Table 3).

The superficial layer at Witkrans 2, also known as Witkrans Pothole (FEP 43-loose, UCMP V67285), is correlated with Little Witkrans on the basis of LSA Wilton artifacts (Peabody 1954). A total of 62 specimens from this locality are housed in the UCMP, of which 20 are cataloged.

Little Witkrans (FEP 40, UCMP V4740) is an LSA deposit under the shelter of a small travertine cliff on the edge of the Kaap escarpment, located 0.3 miles south of Witkrans. Only





**Figure 4.** UCMP specimens from Tunnel Wall (V67278). Eleven ostrich (*Struthio*) eggshell fragments. Note that the fragments do not appear to rejoin.

one specimen from this locality, an equid premolar (UCMP 89601), is stored in the UCMP. Peabody (1954) reports the occurrence of Wilton culture artifacts, including decorated eggshells and beads. The Witkrans area has been dated on the basis of recovered archaeological material, with MSA artifacts recovered from the lower layer and LSA artifacts from the upper layer (Peabody 1954).

*Iscor Lime*—Approximately five miles north of Buxton Limeworks, Iscor Company's quarrying activity removed nearly all the limestone from a travertine mass built out from a canyon incising the edge of the Kaap escarpment. The

resulting abandoned quarry is known as Iscor Lime (FEP 41, UCMP V4741) (Peabody 1954). A small assemblage of fossil mammals was collected from the cave breccia in the walls still intact around the area, as well as from the mining dumps (Peabody 1954). A total of nine specimens from this locality, all unidentified mammals, are housed in the UCMP, although only one is cataloged (UCMP 89602). Peabody (1954) suggests that this locality is possibly comparable in age to the older Buxton travertines, although quarrying activity has made it impossible to reconstruct the history of this travertine.

*Boetsap (Fossil Hill)*—Fossil Hill (FEP 42, UCMP V4742) is separated from the main travertine located near the Kaap escarpment in the Boetsap area, and the only fossils known from this locality occur in the western side of Fossil Hill, two miles southeast of Boetsap. Fifteen specimens from this locality are housed in the UCMP including 11 artiodactyls and four perissodactyls (12 of these specimens are cataloged: UCMP 89603-89614). In addition to faunal remains, plant remains were also collected from Boetsap during the UC Africa Expedition, although no artifacts were collected (Peabody 1954). Peabody (1954) estimates that this young travertine is approximately early Pleistocene in age.

### Faunal composition

The assemblage as a whole is dominated by artiodactyls and rodents, represented at almost every locality. The most notable absence of artiodactyls is at Kiln Pit (UCMP V67257), dominated exclusively by small mammals and birds. Other well-represented taxa in the assemblage include primates, perissodactyls and birds. The assemblage from Upper Australopithecus Cave (UCMP V67275) is comprised almost entirely of primates. The diversity of taxonomic representation, and its distribution across the assemblage, is likely a reflection of the disparity in taphonomic processes and geologic age of the sites.

### CONCLUSION

This manuscript provides a review of the UC Africa Expedition and the history of study on the UCMP Plio-Pleistocene South African collection. In doing so, we note the influence that this collection has had across various fields of study. We provide a summary of the results of our curatorial efforts with the South African Plio-Pleistocene UCMP material, offering a brief overview of the Plio-Pleistocene South African fossil localities represented and the description of three previously unreported South African fossil localities: New Cave, Jackal Cave, and Tunnel Wall. The locality details offered here, including the faunal composition of fossil material, serve to illuminate this UCMP collection and demonstrate the amount and quality of material available for study.

The UC Africa Expedition encompassed varied research aims resulting in the collection of diverse material including: vertebrate, invertebrate, and extant plant and fossil specimens spanning early Permian to modern flora and fauna of South Africa, as well as musical, photographic, ethnographic, and archaeological materials. In describing these collections, we aim to highlight the diversity and remarkable quantity of material collected during the UC Africa Expedition, thereby emphasizing the positive and long-acting impact of large-scale research expeditions.

### ACKNOWLEDGEMENTS

The authors thank curators Pat Holroyd (University of California Museum of Paleontology), Leslie Freund (Phoebe A. Hearst Museum of Anthropology), and Amy Kasameyer (University and Jepson Herbaria) for access to materials. The authors are grateful to the research assistants who helped catalogue and curate the collection: S. Gutierrez, B. Marquez and K. Roth, and R. Takenaka who helped locate historical materials. W. Reiner provided valuable discussion and feedback. This project was supported in part by the University of California Berkeley Pre-IMSD Undergraduate Research Program (B. Marquez), and by award number R25GM090110 from the National Institute of General Medical Sciences (S. Gutierrez). TAM was supported by the University of California Berkeley Chancellor's Fellowship Program during the initial phase of this project. We would like to thank D. Gommery and one anonymous reviewer for their helpful comments, which greatly improved this manuscript.

**Author contributions** – TAM led the research group in curation of the UCMP material and created the figures and tables. MFB and TAM coauthored the manuscript. LJH initiated the project and supervised the research.

### LITERATURE CITED

- Amberson, J. 1978. Memoir, unpublished. BUMED Library and Archives.
- Anonymous. 1947a. Origin of man believed found in 40-million-year-old soil. *Oakland Tribune*. December 15, 1947. South Africa — Supplemental Locality Files, 1945–1992. Folder 7. University of California Museum of Paleontology Archives.
- Anonymous. 1947b. Radio and x-ray to aid in hunt for civilization's hidden secrets. *Portland Press*. April 19, 1947. South Africa — Supplemental Locality Files, 1945–1992. Folder 7. University of California Museum of Paleontology Archives.
- Anonymous. 1947c. Student to join U.C. expedition. *Oakland Tribune*. May 30, 1947. South Africa — Supplemental Locality Files, 1945–1992. Folder 7. University of California Museum of Paleontology Archives.
- Anonymous. 1947d. UC Expedition chief leaves for Africa. *Berkeley Gazette*. October 29, 1947. South Africa — Supplemental Locality Files, 1945–1992. Folder 7. University of California Museum of Paleontology Archives.
- Anonymous. 1947e. UC Paleontologist to try and fix age of man-apes. *Berkeley Gazette*. June 19, 1947. South Africa — Supplemental Locality Files, 1945–1992. Folder 7. University of California Museum of Paleontology Archives.
- Anonymous. 1948. UC's African safari unearths a new clue to 'missing link'. *Berkeley Gazette*. January 29, 1948. South Africa — Supplemental Locality Files, 1945–1992. Folder 7. University of California Museum of Paleontology Archives.
- Anonymous. 1969. Friend of sultan: Explorer writes biography of Jesus. *The Gazette, Montreal*. April 29, 1969. South Africa — Supplemental Locality Files, 1945–1992. Folder 7. University

- of California Museum of Paleontology Archives.
- Badenhorst, S., F. Sénégas, D. Gommery, S. Potze, L. Kgasi, and J. Thackeray. 2011. Pleistocene faunal remains from Garage Ravine Cave on Bolt's Farm in the Cradle of Humankind, South Africa. *Annals of the Ditsong National Museum of Natural History* 1:33–40.
- Berger, L. 1993. A preliminary estimate of the age of the Gladysvale australopithecine site. *Palaeontologia Africana* 30:51–55.
- Berger, L., and J. Brink. 2007. An atlas of southern African mammalian fossil bearing sites — late Miocene to late Pleistocene. Online at: [www.proflieberger.com/files/An\\_Atlas\\_of\\_southern\\_African\\_Fossil\\_Bearing\\_Sites.pdf](http://www.proflieberger.com/files/An_Atlas_of_southern_African_Fossil_Bearing_Sites.pdf)
- Berger, L.R., A.W. Keyser, and P.V. Tobias. 1993. Gladysvale: First early hominid site discovered in South Africa since 1948. *American Journal of Physical Anthropology* 92(1):107–111.
- Boddaert, P. 1785. *Elenchus animalium*, Vol. 1. Sistens Quadrupedia, Rotterdam.
- Brain, C. 1981. *The hunters or the hunted? An introduction to African cave taphonomy*. University of Chicago Press, Chicago. 365 pp.
- Broom, R. 1936. The dentition of *Australopithecus*. *Nature* 138:719.
- Broom, R., and G. Schepers. 1946. The South African fossil man-ape, the Australopithecinae. *Transvaal Museum Memoir* 2:1–272.
- Butzer, K. 1974. Paleocology of South African Australopithecines: Taung revisited. *Current Anthropology* 15(4):367–382.
- Camp, C. 1948. University of California Expedition – Southern Section. *Science* 108(2812):550–552.
- Cooke, H. 1990. Taung fossils in the University of California collections. Pp. 119–134 in G.H. Sperber (ed.). *Apes to Angels: Essays in Anthropology in honor of Philip V. Tobias*. Wiley-Liss, New York.
- Cooke, H. 1991. *Dinofelis barlowi* (Mammalia, Carnivora, Felidae) cranial material from Bolt's Farm, collected by the University of California African Expedition. *Palaeontologia Africana* 28:9–21.
- Cooke, H. 1993a. Undescribed suid remains from Bolt's Farm and other Transvaal cave deposits. *Palaeontologia Africana* 30:7–23.
- Cooke, H. 1993b. Fossil proboscidean remains from Bolt's Farm and other Transvaal cave breccias. *Palaeontologia Africana* 30:25–34.
- Cuvier, G.F., and E. Geoffroy Saint-Hilaire. 1795. *Méthode mammalogique*. *Magasin encyclopédique* Vol. 2.
- Damiani, R. 2008. A giant skull of the temnospondyl *Xenotosuchus africanus* from the Middle Triassic of South Africa and its ontogenetic implications. *Acta Palaeontologica Polonica* 53(1):75–84.
- Dart, R. 1925. *Australopithecus africanus*: the man ape of South Africa. *Nature* 115:195–199.
- Davis, D.H.S. 1959. The barn owl's contribution to ecology and palaeocology. *Ostrich* 30(S1):144–153.
- Delson, E. 1984. Cercopithecoid biochronology of the African Plio-Pleistocene: correlation among eastern and southern hominid-bearing localities. *Courier Forschungsinstitut Senckenberg* 69:199–218.
- Delson, E. 1988. Chronology of South African australopithecine site units. Pp. 317–324 in F.E. Grine (ed.). *Evolutionary History of the 'Robust' Australopithecines*. Aldine de Gruyter, New York.
- Eisenmann, V. 1992. Origins, dispersals, and migrations of *Equus* (Mammalia, Perissodactyla). *Courier Forschungsinstitut Senckenberg* 153:161–170.
- Ernst, R. 1989. Reaction kinetics of protein hydrolysis, amino acid decomposition, and isoleucine epimerization in eggshell of the African ostrich, *Struthio camelus*. Ph.D. diss. University of Arizona, AZ.
- Ewer, R.F. 1956. The fossil carnivores of the Transvaal caves: the Lycyaenas of Sterkfontein and Swartkrans, together with some general considerations of the Transvaal fossil Hyaenids. *Proceedings of the Zoological Society of London*. 124:839–857.
- Forssman, T., K. Kuman, G. Leader, and R. Gibbon. 2010. A Later Stone Age assemblage from Canteen Kopje, Northern Cape. *The South African Archaeological Bulletin* 65(192):204–214.
- Freedman, L. 1965. Fossil and subfossil primates from the limestone deposits at Taung, Bolt's Farm and Witkrans, South Africa. *Palaeontologia Africana* 9:19–48.
- Freedman, L. 1970. A new check-list of fossil Cercopithecoidea of South Africa. *Palaeontologia Africana*. 13:109–110.
- Freedman, L. 1976. South African fossil Cercopithecoidea: A re-assessment including a description of new material from Makapansgat, Sterkfontein and Taung. *Journal of Human Evolution* 5:297–315.
- Gibbard, P., M. Head, M. Walker, and the Subcommission on Quaternary Stratigraphy. 2010. Formal ratification of the Quaternary System/Period and the Pleistocene Series/Epoch with a base at 2.58 Ma. *Journal of Quaternary Science* 25:96–102.
- Gilbert, C. 2007a. Craniomandibular morphology supporting the diphyletic origin of mangabeys and a new genus of the *Cercocebus/Mandrillus* clade, *Procercocebus*. *Journal of Human Evolution* 53(1):69–102.
- Gilbert, C. 2007b. Identification and description of the first *Theropithecus* (Primates: Cercopithecidae) material from Bolt's Farm, South Africa. *Annals of the Transvaal Museum* 44:1–10.
- Gilbert, C. 2013. Cladistic analysis of extant and fossil African papionins using craniodental data. *Journal of Human Evolution* 64:399–433.
- Gingerich, P. 1974. *Proteles cristatus* Sparrman from the Pleistocene of South Africa, with a note on tooth replacement in the aardwolf (Mammalia: Hyaenidae). *Annals of the Transvaal Museum* 29(4):49–55.
- Gommery, D., S. Badenhorst, S. Potze, F. Sénégas, L. Kgasi, and J. Thackeray. 2012. Preliminary results concerning the discovery of new fossiliferous sites at Bolt's Farm (Cradle of Humankind, South Africa). *Annals of the Ditsong National Museum of Natural History* 2:33–45.
- Gommery, D., S. Potze, F. Sénégas, L. Kgasi, S. Prat, and S. Badenhorst. 2010. Bolt's Farm: the kingdom of large cats in the cradle of humankind. Ditsong National Museum of Natural History, Pretoria, South Africa.
- Gommery, D., F. Sénégas, S. Potze, and L. Kgasi. 2014. Les primates non-humains fossiles de Bolt's Farm (Afrique du Sud). Contexte, recherches actuelles et perspectives. *BMSAP* 26:184–189.
- Gommery, D., F. Sénégas, J. Thackeray, S. Potze, L. Kgasi, J. Claude,

- and R. Lacruz. 2008. Plio-Pleistocene fossils from Femur Dump, Bolt's Farm, Cradle of Humankind World Heritage Site. *Annals of the Transvaal Museum* 45:67–76.
- Gray, J. 1824. A revision of the Family Equidae. *Zoological Journal* 1(2): 241–248.
- Hall, M., and J. Vogel. 1980. Some recent radiocarbon dates from southern Africa. *The Journal of African History* 21(4):431–455.
- Herries, A.I.R., R. Pickering, J.W. Adams, D. Curnoe, G. Warr, A.G. Latham, and J. Shaw. 2013. A multi-disciplinary perspective on the age of *Australopithecus* in southern Africa. Pp. 21–40 in Reed, K.E., J.G. Fleagle, and R.E. Leakey (eds.). *The Paleobiology of Australopithecus*, Vertebrate Paleobiology and Paleoanthropology series. Springer, Netherlands.
- Hogan, S. 1990. Out of Africa. University of California Botanical Garden Newsletter. 15(1):8–9.
- Hooker, J.D. 1863. I. On *Welwitschia*, a new genus of Gnetaceae. *Transactions of the Linnean Society of London* 24(1):1–48.
- Hudson, M. 2000. Hugh Tracey: pioneer archivist. Broughton S., M. Ellingham, and R. Trillo (eds.). *World Music Volume 1: Africa, Europe and the Middle East*. Penguin, London.
- Humphreys, H. 1978. The re-excavation of Powerhouse Cave and an assessment of Dr Frank Peabody's work on Holocene deposits in the Taung area. *Annals of the Cape Provincial Museums (Nat Hist)* 11:217–244.
- Humphreys, H., and J. Thackeray. 1983. Ghaap and Gariep: Later Stone Age Studies in the Northern Cape. Cape Town: South African Archaeological Society Monograph 2.
- Huxley, T. H. 1880. On the application of the laws of evolution to the arrangement of the Vertebrata and more particularly of the Mammalia. *Proceedings of the Zoological Society of London* 1880:649–662.
- Klein, R. 1979. Paleoenvironmental and cultural implications of late Holocene archaeological faunas from the Orange Free State and north-central Cape Province, South Africa. *The South African Archaeological Bulletin* 34:34–49.
- Klein, R., K. Cruz-Urbe, and P. Beaumont. 1991. Environmental, ecological, and paleoanthropological implications of the late Pleistocene mammalian fauna from Equus Cave, Northern Cape Province, South Africa. *Quaternary Research* 36(1): 94–119.
- Koch H.J. 1948. A new South African volute. *Journal of Conchology* 23(1):5–6.
- Kützing, F.T. 1843. *Phycologia generalis: oder anatomie, physiologie un systemkunde der Tange*. Brockhaus, Leipzig.
- Larson, T.J. 2004. *The Great Adventure: The University of California Southern Africa Expedition of 1947–1948*. iUniverse, Inc., Lincoln.
- Linnaeus, C. 1758. *Systemae naturae*. Ed. 10, Vol. 1. Salvii, Holmiae.
- Malan, B. 1950. The Middle Stone Age in the Eastern Transvaal and Swaziland. *South African Journal of Science* 47(5S):146–150.
- Martini, J., and A. Keyser. 1989. The caves of the John Nash Game Reserve in the Krugersdorp area. *Bulletin of the South African Speleological Association* 30:39–46.
- McCrossin, M. 1992. Human molars from later Pleistocene deposits of Witkrans Cave, Gaap Escarpment, Kalahari Margin. *Human Evolution* 7(3):1–10.
- McKee, J. 1993. Formation and geomorphology of caves in calcareous tufas and implications for the study of the Taung fossil deposits. *Transactions of the Royal Society of South Africa* 48(2):307–322.
- McKee, J. 1994. Catalogue of fossil sites at the Buxton Limeworks, Taung. *Palaeontologia Africana* 31:73–81.
- Morales, M., and M. Shishkin. 2002. A re-assessment of *Parotosuchus africanus* (Broom), a capitosauroid temnospondyl amphibian from the Triassic of South Africa. *Journal of Vertebrate Paleontology* 22:1–11.
- Nicol, H. 1947. Scientists leave Berkeley for year's work. *Berkeley Gazette*. July 11, 1947.
- Pallas, P.S. 1766. *Miscellanea zoologica: Quibus novae imprimus atque obscurae animalium species. Describuntur et observationibus iconibusque illustrantur*. Petrum van Cleff, The Hague, The Netherlands.
- Pallas, P.S. 1767. *Antilope pygargus*. *Spiciligia Zoologica* 1:10.
- Parkington, J., and M. Hall. 1987. Patterning in recent radiocarbon dates from southern Africa as a reflection of prehistoric settlement and interaction. *The Journal of African History* 28(1):1–25.
- Partridge, T. 1973. Geomorphological dating of cave openings at Makapansgat, Sterkfontein, Swartkrans and Taung. *Nature* 246:75–79.
- Partridge, T. 1985. Spring flow and tufa accretion at Taung. Pp. 171–187 in Tobias, P., V. Strong, and H. White (eds.). *Hominid Evolution: Past, Present and Future*. Wiley-Liss, New York.
- Peabody, F. 1954. Travertines and cave deposits of the Kaap Escarpment of South Africa, and the type locality of *Australopithecus africanus* Dart. *Geological Society of America Bulletin* 65(7):671–706.
- Pellegatti, P. 2013. Pounders and quern. Hearst Museum. January 30, 2013.
- Pellegatti, P. 2014. Focus on the collection: excavations in our collection. Hearst Museum.
- Pillalamarri, A. 2014. Unearthing Arabia: The archaeological adventures of Wendell Phillips. *The Diplomat*. October 25, 2014.
- Ray, P. 1947. U.C. scientists hunt wilds of Africa for specimens. *Oakland Tribune*. December 18, 1947.
- Ray, P. 1948. U.C. explorers hold first joint meeting since reaching Africa. *Oakland Tribune*. May 4, 1948.
- Reynolds, S. 2007. Temporal variation in Plio-Pleistocene *Antidorcas* (Mammalia: Bovidae) horncores: the case from Bolt's Farm and why size matters. *South African Journal of Science* 103:47–50.
- Rodin, R. 1947. Letter to Lincoln Constance. U.C. University and Jepson Herbaria Archives.
- Rodin, R. 1948. U.C. African Expedition field notes, unpublished. U.C. University and Jepson Herbaria Archives.
- Rodin, R. 1951. Petrified forest in South-West Africa. *Journal of Paleontology* 25(1):18–20.
- Rodin, R. 1953. Seedling morphology of *Welwitschia*. *American Journal of Botany* 40(5):371–378.
- Rodin, R. 1985. The ethnobotany of the Kwanyama Ovambos. Monographs in systematic botany from the Missouri Botanical Garden.

- Schlosser, M. 1910. Über einige fossile Säugetiere aus dem Oligocän von Ägypten. *Zoologischer Anzeiger* 34:500–508.
- Schreber, J. 1775. Die Säugetiere in Abbildungen nach der Natur mit Beschreibungen. Walther, Erlangen.
- Sénégas, F., and D.M. Avery. 1998. New evidence for the murine origins of the Otomyiinae (Mammalia, Rodentia) and the age of Bolt's Farm (South Africa). *South African Journal of Science* 94:503–507.
- Seward, A.C. 1917. Fossil plants, Vol. 3. Cambridge University Press, London.
- Sobocinski, A. 2013. The taming of the elephant shrew: A look back at Navy Medicine's 1948 expedition from Cairo to Cape Town. Navy Medicine Live.
- Szalay, F., and E. Delson. 1979. Evolutionary History of the Primates. Academic Press, New York. 580 pp.
- Thackeray, J., D. Gommery, F. Sénégas, S. Potze, L. Kgasi, C. McCrae, and S. Prat. 2008. A survey of past and present work on Plio-Pleistocene deposits on Bolt's Farm, Cradle of Humankind, South Africa. *Annals of the Transvaal Museum* 45:83–89.
- Tobias, P. 1968. Letter to Eric Delson. July 23, 1968. South Africa – Supplemental Locality Files, 1945–1992. Folder 4. University of California Museum of Paleontology Archives.
- Tomlin, J. 1918. On *Siliquaria wilmanae*, n.sp., from South Africa. *Proceedings of the Malacological Society* 13(1/2):16.
- Tomlin, J. 1926. On South African marine Mollusca, with descriptions of new species. *Annals of the Natal Museum* 5(3):283–301.
- Tomlin, J. 1947. A new South African volutid. *Journal of Conchology* 22(10):224–246.
- Turner, E. 1948. U.C. explorer back with elephant shrew cargo. *Berkeley Gazette*. June 14, 1948.
- Vogel, J., and T. Partridge. 1983. Preliminary radiometric ages for the Taung tufas. Pp. 507–514 in J. Vogel (ed.). Late Cainozoic: Palaeoclimates of the Southern Hemisphere. Balkema, Rotterdam.
- Vogt, A. 2004. National monuments in Namibia: an inventory of proclaimed national monuments in the Republic of Namibia. Gamsberg Macmillan, Windhoek, Namibia
- Vrba, E. 1979. Phylogenetic analysis and classification of fossil and recent Alcelaphini Mammalia: Bovidae. *Biological Journal of the Linnean Society* 11(3):207–228.
- Wadley, L. 2000. The Wilton and pre-ceramic post-classic Wilton industries at Rose Cottage Cave and their context in the South African sequence. *The South African Archaeological Bulletin* 55:90–106.
- Wagler, H. 1827. Footnote to a letter of H. Boie in *Isis* 20:726.
- Walton, L., and D. Joly. 2003. *Canis mesomelas*. *Mammalian Species* 715:1–9.
- Welles, S., and J. Cosgriff. 1965. A revision of the labyrinthodont family Capitosauridae and a description of *Parotosaurus peabodyi*, n. sp. from the Wupatki Member of the Moenkopi Formation of northern Arizona. *University of California Publications in Geological Sciences* 54:1–148.
- World Heritage Committee. 2005. Decisions of the 29th session of the World Heritage Committee. Paris, France: UNESCO World Heritage Centre.
- Young, R. 1925. The calcareous tufa deposits of the Campbell Rand, from Boetsap to Taungs Native Reserve. *Transactions of the Geological Society of South Africa* 28:55–67.